

**PREVALENCE, PERCEPTIONS, AND CORRELATES OF PHYSICAL
ACTIVITY AMONG YOUTH IN NEW ZEALAND**

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A thesis submitted to
Auckland University of Technology
in fulfilment of the requirements for the degree of
Doctor of Philosophy (PhD)

2008

School of Sport and Recreation

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Table of Contents

List of Tables	viii
List of Figures	x
List of Appendices	xi
List of Abbreviations	xii
Attestation of Authorship	xiii
List of Publications Arising From This Doctoral Thesis	xiv
Peer-reviewed Journal Publications.....	xiv
Conference Presentations	xv
Acknowledgements	xvii
Confirmation of Ethics Approval	xviii
Abstract	xix
Chapter 1: Introduction	22
Physical Inactivity.....	22
Thesis Aims	23
Series of Projects and Studies	24
Study Objectives.....	26
Thesis Rationale	27
Target Population	27
Physical Activity Measurement Tools	27
Significance of this Research.....	29
Thesis Structure.....	30
Chapter 2: Fundamentals of Physical Activity Research	32
Definitions of Key Terms.....	32
Physical Activity, Exercise, and Physical Fitness	32
Dimensions of Physical Activity	32
Taxonomy of Physical Activity	33
Taxonomy of Individuals - Physically Active, Inactive, and Sedentary.....	34
Health Benefits Conferred Through an Active Lifestyle.....	35
Short-Term Health Benefits	36

Tracking of Physical Activity	36
Impact on Future Adult Health	37
Activity Guidelines.....	38
Physical Activity Guidelines	38
Physical Activity Guidelines for Children and Young People	38
Recreational Screen-Use Guidelines.....	43
Chapter 3: Measurement of Physical Activity	45
Challenges with Measuring Physical Activity	45
Criterion Measurement Tools.....	48
Secondary Measures	51
Heart Rate Monitors	51
Motion Sensors.....	52
Subjective Measures.....	62
Measurement Tool Type.....	62
Survey Formats	63
Methods of Administration	63
Self-Report Surveys	64
Reliability and Validity.....	67
Limitations	67
Chapter 4: Epidemiology of Youth Physical Activity.....	71
Physical Activity Levels.....	71
National Prevalence of Active Youth	71
Accelerometer Data.....	73
Daily Step Counts.....	74
Physical Activity Patterns.....	77
Age Trends.....	77
Sex	77
Ethnicity	78
Socioeconomic Status	79
Obesity	81
Day of Week.....	83

Time Trends	84
Domain and Time Specific Physical Activity Levels	85
Importance of Domain and Time-Specific Physical Activities	85
Sport.....	88
Physical Education	91
School Recess.....	92
After-School Activity	92
Active Travel To and From School	93
Conclusion and Future Research.....	96
Chapter 5: Correlates of Youth Physical Activity.....	98
Theoretical Models and Frameworks of Behaviour	98
Individual Factors.....	100
Age, Gender, and Maturation	100
Ethnicity and Socioeconomic Status.....	100
Psychological Correlates	101
Sedentary Behaviours	103
Physical Environment	106
Home Environment.....	106
School Environment	107
Neighbourhood Environment.....	108
Conclusion.....	114
Social Environment	116
Role Modelling.....	116
Logistical Support.....	118
Encouragement	118
Social Support	119
Family Composition	120
Relative Contribution: Individual versus Environmental Factors	121
Conclusion, Limitations, and Future Research.....	123
Chapter 6: Pedometer-Determined Physical Activity Levels of Adolescents.....	125
Preface	125

Introduction	126
Methods	128
Sample	129
Measures	130
Data Collection	131
Data Analysis.....	131
Results	133
Daily Step Counts.....	133
Engagement in Active Transportation.....	133
Achievement of the 10,000 Steps per Day Criterion.....	135
Discussion	135
Chapter 7: Self-Reported Physical Activity Levels during a Segmented School Day	140
Preface	140
Introduction	142
Methods	143
Data Collection	143
Sample	143
Measures.....	143
Data Analysis.....	145
Results.....	145
Engagement across Individual Physical Activity Opportunities.....	145
Engagement across Multiple Physical Activity Opportunities.....	150
Level of Agreement between Various Physical Activity Opportunities	150
Discussion	150
Chapter 8: Youth Perceptions of Physical Activity.....	154
Preface	154
Introduction	155
Methods	156
Sample	156
Focus Group Procedure	156
Focus Group Schedule.....	157

Focus Group Analyses	158
Results.....	158
Perceived Benefits of Participating In Physical Activity	158
Barriers to Participating in Physical Activity	160
Physical Activity Enhancing Strategies	163
Discussion	167
Chapter 9: Social Support and Youth Physical Activity: Importance of Siblings, Cousins, Parents, Friends, and School Support.....	172
Preface	172
Introduction	173
Methods	174
Data Collection	174
Sample	175
Measures.....	175
Data Analysis.....	178
Results.....	178
After-School Activity	178
Lunchtime Physical Activity	181
Active Transportation.....	183
Discussion	185
Chapter 10: Associations between After-School Physical Activity, Television Use, and Parental Strategies	189
Preface	189
Introduction	190
Methods	192
Data Collection	192
Sample	192
Measures.....	193
Data Analysis.....	195
Results.....	195
Physical Activity and TV Viewing Descriptives	195
Television Watching - After-School Physical Activity Association.....	196

Parental Practices and Youth Activity Behaviours	197
Discussion	198
Chapter 11: Discussion	201
Overview of the Projects	201
Physical Activity Patterns	201
Reported Findings	201
Contribution to Existing Literature.....	202
Practical Implications.....	202
Correlates of Physical Activity.....	204
Reported Findings	204
Contribution to Existing Literature.....	206
Practical Implications.....	207
Methodological Limitations.....	208
Sample	209
Measurement.....	209
Study Design	211
Future Directions.....	212
Measurement.....	212
Ecological Approach.....	212
Social versus Physical Environment Debate	213
New Zealand Physical Activity Monitoring System for Children and Youth .	213
Sedentary Behaviours	214
Promotion of Physical Activity.....	214
Conclusion	215
References.....	217
Appendices.....	262

List of Tables

Table 1: Examples of Physical Activity Recommendations for Children and Adolescents	40
Table 2: Examples of Step-Based Physical Activity Recommendations	43
Table 3: Synopsis of Key Attributes for Current Methods to Measure Physical Activity in Children and Adolescents.....	47
Table 4: Psychometric Properties of a Selection of Secondary Measures in Children and Youth	55
Table 5: Examples of Youth-Specific Accelerometer Count Thresholds and Prediction Equations.....	58
Table 6: Examples of Subjective Measures of Youth Physical Activity and Associated Characteristics	65
Table 7: Examples of Subjective Measures of Youth Physical Activity and Associated Reliability and Validity	69
Table 8: Examples of National Physical Activity Surveys and Most Recent Physical Activity Levels of Youth	72
Table 9: A Selection of Studies Examining Daily Step Counts Among the Child and Youth Populations.....	76
Table 10: Selection of Population Studies and Respective Findings of Youth Sport Participation Levels	90
Table 11: Active Transportation Levels from a Sample of Population Studies..	94
Table 12: Estimated Daily Step Counts (\pm Standard Error) According to Sex, Age Group, and Time of Week, Adjusted for Each Other.	133
Table 13: Estimated Weekday Daily Step Counts (\pm standard error) According to Mode of Transportation and Adjusted by Age and Sex.....	134
Table 14: Percentage of Students Participating in Each Transport Mode by School.....	134
Table 15: Percentage of Students Who Meet the 10,000-Step Criterion	135
Table 16: Percentage of Participants Categorised as 'More Active' Across Four Physical Activity Opportunities.....	147
Table 17: Crude Odds Ratios of Being Categorised as 'More Active' Across Four Physical Activity Opportunities by a Selection of Demographic Variables.....	148

Table 18: Adjusted Odds Ratios of Being Categorised as ‘More Active’ Across Four Physical Activity Opportunities by a Selection of Demographic Variables.....	149
Table 19: Core Focus Group Questions	157
Table 20: Perceived Benefits Identified.....	159
Table 21: Perceived Barriers Identified	161
Table 22: Potential Physical Activity Promoting Strategies Identified.....	165
Table 23: Univariate and Multivariate Analysis of Perceived Support From Various Sources for Participation in After-School Physical Activity..	180
Table 24: Univariate and Multivariate Analysis of Perceived Support from Various Sources for Participation in Lunchtime Physical Activity.....	182
Table 25: Univariate and Multivariate Analysis of Perceived Support from Various Sources for Participation in Active Transportation Association	184
Table 26: Percentage of Participants Engaging in Various Levels of After-School Activity and Weekday TV Use.....	196
Table 27: Adjusted Odds Ratio between Physical Activity and TV Use during the After-School Period.....	197
Table 28: Percentage of Students by Level of Parental Strategies and Student TV/Physical Activity Behaviour	197
Table 29: Association between Parental Strategies and Child’s Activity Behaviours.....	198

List of Figures

Figure 1: Illustration of the Thesis Structure	25
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List of Appendices

Appendix A: Ethics Approval (Project 1)	263
Appendix B: Consent Form for School Principals (Project 1).....	264
Appendix C: Participant Assent and Parental Consent Form (Project 1)	265
Appendix D: Consent Form for Participants \geq 16 years old (Project 1)	266
Appendix E: Information Sheet for School Principals (Project 1)	267
Appendix F: Information Sheet for Parents of Participants < 16 years old (Project 1)	269
Appendix G: Information Sheet for Participants (Project 1).....	271
Appendix H: Survey (Project 1).....	273
Appendix I: Ethics Approval (Project 2).....	275
Appendix J: Consent Form for School Principals (Project 2)	276
Appendix K: Parental Consent Form (Project 2)	277
Appendix L: Participant Assent Form (Project 2)	278
Appendix M: Information Sheet for School Principals (Project 2).....	279
Appendix N: Information Sheet for Parents (Project 2)	281
Appendix O: Information Sheet for Participants (Project 2).....	283
Appendix P: Focus Group Schedule (Project 2).....	285
Appendix Q: Ethics Approval (Project 3).....	286
Appendix R: Consent Form for School Principals (Project 3).....	287
Appendix S: Participant Assent and Parental Consent Form (Project 3)	288
Appendix T: Participant Consent Form (Project 3).....	289
Appendix U: Information Sheet for Students Aged < 16 years old (Project 3).	290
Appendix V: Information Sheet for Students Aged \geq 16 years old (Project 3).	292
Appendix W: Information Sheet for Parents (Project 3)	294
Appendix X: Survey Questions (Project 3).....	296
Appendix Y: Adolescent Obesity and Physical Inactivity.....	306
Appendix Z: Physical Activity: What do High School Students Think?	319
Appendix AA: Social support for youth physical activity: Importance of siblings, parents, friends and school support across a segmented school day	328
Appendix BB: Pedometer-Determined Physical Activity Levels of Adolescents: Differences by Age, Sex, Time of Week, and Transportation Mode to School.....	337

List of Abbreviations

Abbreviation	Definition
AOR	Adjusted odds ratio
BMI	Body mass index
bpm	Beats per minute
CI	Confidence interval
cm	Centimetres
cpm	Counts per minute
DLW	Doubly labelled water
DO	Direct observation
GEE	Generalising estimating equations
HR	Heart rate
hr	Hour(s)
κ	Kappa coefficient
kg	Kilogram (0.45kg = 1 pound)
m	Metre(s)
MET	Metabolic equivalent
min	Minute(s)
MPA	Moderate physical activity
MVPA	Moderate-to-vigorous physical activity
n	Sample size
ns	Nonsignificant
OR	Odds ratio
%	Percent
\pm	Plus or minus
SD	Standard deviation
SE	Standard error
TV	Television
VPA	Vigorous physical activity
wk	Week

Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

This doctoral thesis contains five papers (represented as individual chapters, Chapters 6 to 10) that have been submitted to peer-reviewed journals for publication. Of the five papers developed, three papers have been published in peer-reviewed journals (Chapters 6, 8, and 9) and two papers have been accepted for publication (Chapters 7 and 10). The relative contribution to each paper from the candidate and respective co-authors is outlined in Chapter 1. For each manuscript, the candidate received guidance from the co-authors but contributed the majority of work. Prior to development, all co-authors were aware that each manuscript would constitute the candidate's thesis and, therefore, approved the inclusion of each paper in this thesis.

October 2008

List of Publications Arising From This Doctoral Thesis

Peer-reviewed Journal Publications

Hohepa, M., Schofield, G., & Kolt, G. S. (2004). Adolescent obesity and physical activity. *New Zealand Medical Journal*, 117, 1210-1223.

(Appendix Y)

Hohepa, M., Schofield, G., & Kolt, G. S. (2006). Physical activity: What do high school students think? *Journal of Adolescent Health*, 39, 328-336.

(Appendix Z)

Hohepa, M., Scragg, R., Schofield, G., Kolt, G.S., & Schaaf, D. (2007). Social support for youth physical activity: Importance of siblings, parents, friends and school support across a segmented school day. *International Journal of Behavioral Nutrition and Physical Activity*, 4.

doi:10.1186/1479-5868-4-54. (Appendix AA)

Hohepa, M., Schofield, G., Kolt, G.S., Scragg, R., & Garrett, N. (2008).

Pedometer-determined physical activity levels of adolescents:

Differences by age, sex, time of week, and transportation mode to

school. *Journal of Physical Activity and Health*, 5, 140-152 (Appendix

BB)

Hohepa, M., Scragg, R., Schofield, G., Kolt, G.S., & Schaaf, D. (In press). Self-reported physical activity levels during a segmented school day in a large multiethnic sample of high school students. *Journal of Science and Medicine in Sport*.

Hohepa, M., Scragg, R., Schofield, G., Kolt, G.S., & Schaaf, D. (In press).

Associations between after-school physical activity, television use, and parental strategies in a sample of New Zealand adolescents. *Journal of Physical Activity and Health*.

In this thesis, Chapters 6 to 10 represent five of six aforementioned papers that have been submitted for publication, or currently published in, international peer-reviewed journals. Each chapter was developed in collaboration between the candidate, the candidate's PhD Supervisors (Professor Grant Schofield, Professor Gregory Kolt, and Associate Prof Robert Scragg), and two research associates (Dr David Schaaf, Nick Garrett). The candidate conceived the key questions answered and contributed the majority

of work to each manuscript. All co-authors were aware that the papers were developed for the purpose of the candidate's thesis. The academic contribution from each author towards the development of each paper is outlined below.

Chapter 6: Pedometer-determined physical activity levels of adolescents.

Hohepa, M (85%) Schofield, G (7%) Kolt, G.S (5%), Scragg, R. (2%) & Nick Garrett (1%)

Chapter 7: Self-report physical activity levels during a segmented school day.

Hohepa, M (85%) Schofield, G (6%) Kolt, G.S (5%), Scragg, R. (2%), & Schaaf, D (2%)

Chapter 8: Youth perceptions of physical activity. Hohepa, M (85%) Schofield,

G (6%) Kolt, G.S (5%), Scragg, R. (2%), & Schaaf, D (1%)

Chapter 9: Social support and youth physical activity. Hohepa, M (85%)

Schofield, G (6%) Kolt, G.S (5%), Scragg, R. (2%), & Schaaf, D (2%)

Chapter 10: Associations between after-school physical activity, television use,

and parental strategies. Hohepa, M (85%) Schofield, G (6%) Kolt, G.S (5%), Scragg, R. (2%), & Schaaf, D (2%)

Conference Presentations

Hohepa, M., Schofield, G., & Kolt, G. S. (2003). *Are New Zealand youth*

obese and physically inactive? Proceedings of the New Zealand Sports Medicine and Science Conference (p. 76). Nelson, New Zealand: Sports Medicine New Zealand.

Hohepa, M. (2005). *Physical activity among youth in New Zealand: Prevalence, perceptions, and potential influences.* Proceedings of Hui Whakapiripiri, Christchurch, New Zealand.

Scragg, R., Schaaf, D., Hohepa, M., Utter, J., & Schofield, G. (2005). *OPIC: a youth focused obesity prevention initiative.* Proceedings of the Call to Action, Kawea Ake Te Wero: National Nutrition and Physical Activity Public Health Conference, Christchurch, New Zealand.

- Hohepa, M., Schofield, G., & Kolt, G. S. (2005). *Perceptions of physical activity among youth in New Zealand*. Proceedings of the Scientific Conference of the Australasian Society for Behavioural Health and Medicine (p. 54), Melbourne, Australia: Australasian Society for Behavioural Health and Medicine.
- Hohepa, M., Swinburn, B., Scragg, R., & Pyror, J. (2005). *OPIC: A youth focussed obesity prevention project*. Abstracts of the Fifth National Physical Activity Conference, Melbourne, Australia. *Journal of Science and Medicine in Sport*, 8, 75.
- Hohepa, M., Schofield, G. M., & Kolt, G. S. (2006). *Pedometer-determined habitual physical activity levels of New Zealand high school students*. Abstracts of the American College of Sports Medicine 53rd Annual Meeting, Denver, CO, USA. *Medicine & Science in Sports & Exercise*, 38, s473.
- Hohepa, M., Schofield, G. M., & Kolt, G. S. (2006). *Walking to school: Is this a rare activity among New Zealand high school students?* Proceedings of the 4th Annual Scientific Conference of the Australasian Society for Behavioural Health and Medicine, Auckland, New Zealand.

Acknowledgements

I would like to take this opportunity to thank everyone who provided support while I completed this thesis. I am sincerely grateful to the New Zealand Health Research Council of New Zealand for their financial support in the form of a Māori PhD Scholarship. To the schools and students who kindly agreed to participate, I thank you for the time you gave and for your co-operation throughout the data collection process. This has been a long journey (much longer than expected) and, therefore, I would like to thank my supervisors, Professor Grant Schofield, Professor Gregory Kolt, and Professor Robert Scragg who provided continual and valuable input over the years.

Also, I would like to acknowledge the assistance several other people provided at different time points: Nick Garrett who provided statistical guidance; the OPIC crew at the University of Auckland with whom I collected the data for Project 3; Katrina van der Wende who provided research assistance, my fellow PhD peers who provided insightful discussions; and SPARC (especially Grant McLean) who provided the opportunity to devote part of my work time to completing my thesis. Lastly, aroha nui to Will, my family, and friends who kept (and continue to keep) me grounded and who provided the timely and much needed escapes and words of encouragement during the past few years.

Confirmation of Ethics Approval

Project 1:

Approved by the Auckland University of Technology Ethics Committee on 21 July 2005 (reference number 05/89). A copy of the approval letter is located in Appendix A.

Project 2:

Approved by the Auckland University of Technology Ethics Committee on 29 April 2004 (reference number 04/68). A copy of the approval letter is located in Appendix I.

Project 3:

Approved by the University of Auckland Human Participants Ethics Committee on 1 December 2004 (reference number 2004/429). A copy of the approval letter is located in Appendix Q.

Abstract

Sufficient physical activity, a key prerequisite for health, is lacking in many teenagers. Limited knowledge, however, exists about who, when, why, and if New Zealand teenagers are getting their daily dose of health-related physical activity. At conception of this thesis, available information was predominantly survey-derived with no New Zealand data and few international studies that had assessed adolescent physical activity levels objectively.

Data were collected from three projects. Convenience sampling was used across all projects to recruit students from low-decile high schools located in the Auckland region. For Project 1, 236 Year 9 to Year 13 students each wore a pedometer for five days (three weekdays and two weekend days) and reported their mode of transportation to and from school. To explore ethnic and sex-specific perceptions of physical activity among youth (i.e., barriers, benefits, potential physical activity enhancing strategies), Project 2 involved nine focus group discussions with 44 Year 9 and Year 10 students who identified as Māori or European. Project 3 was a large cross-sectional study of 3,451 high school students (Years 9 - 13) from seven low-decile schools. Through this project the following self-reported data were collected: demographics, physical activity levels during four school-day physical activity opportunities (i.e., active travel, lunchtime physical activity, recess physical activity, after-school physical activity), sedentary behaviour (i.e., school-day television (TV) watching), level of perceived encouragement to be active, and the presence of home policies regarding TV use.

Analyses revealed low physical activity participation and high TV use behaviours. Pedometer data showed that only 14.5% of participants achieved a conservative criterion of 10,000 steps daily. Also, daily steps varied by age group (junior students: 11,079 ± 330; senior students: 9,422 ± 334), sex (males: 10,849 ± 381; females: 9,652 ± 289), time of week (weekday: 12,259 ± 287; weekend day: 8,241 ± 329), and transportation mode to/from school (walkers: 13,308 ± 483; car transit users: 10,986 ± 435). Low school-day physical activity levels emerged, especially during school hours (i.e., during recess and lunchtime). Based on dichotomised grouping (less active versus more active), the proportion of students in the 'more active' group during morning recess and lunchtime, after school, and as part of active travel to/from school were 26%,

32.4%, 56.3%, 58.1% respectively. Only 11.1% of participants were in the 'more active' group across all four physical activity opportunities.

The focus group data revealed primarily social benefits of physical activity (e.g., meeting new people, fun). Barriers were mainly environment-related and included lack of peer support, low accessibility to and availability of physical activity opportunities, alternative sedentary activities, structure of physical education classes (females only), and distance between home and school (in terms of active transportation). Potential strategies to increase physical activity reflected the articulated barriers and benefits (e.g., increase peer support, parents to turn off the TV, organised activities at school, restructure physical education classes to allow student involvement in the decision-making process of class content). No ethnic and few sex differences in perceptions were found.

Focusing on the verbalised importance of social support from the focus groups, Project 3 data showed that the strength of association between perceived encouragement from different support sources (i.e., parents, older siblings/cousins, peers, school) and physical activity participation varied by the physical activity opportunity examined. In particular, multivariate logistical regression showed reduced odds of being in the 'more active' group was associated with low parental encouragement (Juniors, OR: 0.47, 95% CI: 0.38-0.58; Seniors, OR: 0.41, 95% CI: 0.29-0.60) and low peer encouragement (Juniors, OR: 0.61, 95% CI: 0.51-0.74; Seniors, OR: 0.49, 95% CI: 0.35-0.69) for after-school physical activity, low peer encouragement (Juniors, OR: 0.39, 95% CI: 0.32-0.48; Seniors, OR: 0.41, 95% CI: 0.29-0.57) for lunchtime activity, and low peer encouragement (Juniors, OR: 0.78, 95% CI: 0.66-0.92) for active transportation (junior students only). No significant difference in physical activity was found between students who received high encouragement from two parents than students who reported high encouragement from their sole parent in a single parent family.

Concentrating on the after-school period, Project 3 data were analysed to examine the relevance of the displacement hypothesis during this school-day period. The association between parental strategies (i.e., encouragement to be active and having TV limits) and youth after-school activity behaviours (i.e., hours spent viewing TV, physical activity participation) was also examined. Support for the displacement hypothesis emerged. In particular, compared to

students who watched less than one hour of TV, those who watched greater than four hours of TV were half as likely to be in the more active group for after-school physical activity participation (adjusted OR: 0.51; 95% CI: 0.40-0.65). Comparing activity profile groups (i.e., based on combined TV use and after-school activity levels), compared to the participants in the 'low TV/active' group, participants in the other three activity groups (e.g., 'high TV/low active') were at least 1.28 times more likely to have parents that executed only one parental strategy and up to 4.77 times more likely to have parents that did not carry out either strategy.

Substantive opportunities exist for youth to be active every day, and in different contexts and environments, yet a large proportion of young people are not maximising these opportunities to be active. If the health issue of inactivity is to be tackled in a comprehensive and efficient manner, a multi-strategy, multi-environment, coordinated approach among local authorities, government agencies, schools, families, and neighbourhoods is required to address the noted policy, physical, and social-related associates of an active lifestyle for youth. Future effort, whether in the form of strategy development, intervention work, or research, needs to be founded upon ecological theory, where both individual and a range of familial, social, and physical environmental factors (and their potential interactions) are considered. Lastly, equal research attention should be directed at improved physical activity levels, and just as importantly, reducing time youth spend in a sedentary state.

Chapter 1: Introduction

Physical Inactivity

“Physical inactivity (a lack of physical activity) is estimated to cause, globally, about 10-16% of cases each of breast cancer, colon and rectal cancers and diabetes mellitus, and about 22% of ischaemic heart disease. Overall, 1.9 million deaths are attributable to physical inactivity” (World Health Organization, 2002).

For most of human existence physical activity has been an inevitable part of daily living, a requirement for subsistence (US Department of Health and Human Services, 1996). Over the past 100 years labour saving devices developed as a result of considerable technological and environmental changes ensure humans no longer need to be physically active to function in today's society. As a consequence, the level of physical activity undertaken by many people is not sufficient to confer health benefits and places individuals at increased risk of developing chronic lifestyle-related health conditions including obesity, cardiovascular disease, and type II diabetes mellitus as well as advancing premature mortality (Department of Health, 2004; Strong et al., 2005; US Department of Health and Human Services, 1996). Next to tobacco smoking, physical inactivity ranks second in importance for the burden of disease and disability from all-causes in Australia (Mathers, Vos, Stevenson, & Begg, 2000). In New Zealand, at least 2,000 deaths, annually, are estimated to be attributable to physical inactivity (Ministry of Health, 2003b).

Young people are now growing up in a technology-saturated environment that consists of an assortment of alluring sedentary pastimes and energy-saving options. Reports indicate that children today expend approximately 600 kcal.days⁻¹ less than their counterparts 50 years ago (Boreham & Riddoch, 2001). While global estimates of youth inactivity are not known, a recent World Health Organization (WHO) collaborative cross-national study reported that among 15-year-olds from 34 countries (Europe and America regions) 66% of boys and 78% of girls were considered inactive, that is, they did not achieve the current recommendation of 60 minutes of moderate intensity physical activity on at least five days per week (Currie et al., 2004). National statistics also show that in many countries at least one-quarter of all young

people are deemed physically inactive (Centers for Disease Control and Prevention, 2006a; Sport and Recreation New Zealand, 2003). Alongside low activity levels, adolescents are characterised by declining levels during the high school years (Kimm et al., 2002; Kimm et al., 2000; Klasson-Heggebo & Anderssen, 2003; Telama & Yang, 2000; Van Mechelen, Twisk, Post, Snel, & Kemper, 2000). Consequently, teenagers are an at-risk group for inactivity. Add low socioeconomic status into the mix and the risk of various chronic health conditions and premature mortality increases (Ministry of Health & University of Otago, 2006). Compared to young people from higher socioeconomic status groups, young people from low socioeconomic status backgrounds have demonstrated lower physical activity levels (Inchley, Currie, Todd, Akhtar, & Currie, 2005; Raudsepp, 2006), lower participation rates in physical education classes (Sallis, Zakarian, Hovell, & Hofstetter, 1996b), and lower engagement levels in out-of-school activity lessons (Sallis et al., 1996b), organised activities (Santos, Esculcas, & Mota, 2004), extracurricular activities (La Torre et al., 2006), and organised sport (Statistics Canada, 2000). Māori and Pacific people are disproportionately represented in the most deprived groups in New Zealand. Consequently, public health policies highlight the need to address physical inactivity among the youth population group, particularly among Māori and Pacific people (Ministry of Health, 2003a).

Thesis Aims

At conception of this thesis, the current international literature clearly illustrated low physical activity levels among youth and that physical activity levels declined during adolescence. Additionally, only a developing knowledge of the determinants of physical activity in this age group existed. At the same time, national strategies in New Zealand highlighted young people as a population group at risk of poor health behaviours (Ministry of Health, 2003a), yet, physical activity knowledge specific to the youth population in New Zealand was substantially lacking. To provide important knowledge, investigating the patterns and correlates of physical activity among youth in New Zealand became the overarching aim of this thesis. More specifically, four key aims were to:

1. describe high school students' daily physical activity levels objectively with pedometers;

2. examine high school students' physical activity levels during four physical activity opportunities that exist during a school day (i.e., active travel, recess activity, lunchtime activity, after-school activity);
3. examine ethnic and sex-specific perceptions of physical activity among high school students'; and
4. explore potential demographic and socio-environmental correlates of youth physical activity during specific school-day time periods.

Series of Projects and Studies

Figure 1 provides a visual depiction of the structure of, and objectives examined in, this thesis. To achieve the aforementioned aims, three separate, but related, projects were undertaken. Each project used cross-sectional and convenience samples of participants recruited from various low decile secondary schools in the greater Auckland region.

Project 1 consisted of 236 participants ranging from Year 9 through to Year 13 school levels. Each participant wore a seven-day-memory pedometer for five days (three weekdays and two weekend days) and self-reported their mode of travel to and from school for the same school days on which the pedometer was worn.

To examine perceptions of physical activity according to ethnicity and sex for Project 2, nine focus groups were conducted with a total of 44 Year 9 and 10 students from three low decile high schools. Discussions held focused on the participants views about various physical activity contexts and potential physical activity promoting strategies.

Project 3 consisted of the baseline data from 3,451 high school students participating in the Obesity Prevention in Communities' (OPIC) project. This project, which is being conducted across four countries (Fiji, Tonga, Australia, New Zealand), is an obesity prevention initiative targeting high school students in a predetermined suburb/neighbourhood per country. The New Zealand arm is targeting high school students in South Auckland. University of Auckland researchers within the School of Population Health are leading this OPIC project. The author of this thesis was involved in the initial development and baseline collection aspects of the OPIC project. OPIC data regarding physical activity levels, TV use and environmental factors were analysed as part of Project 3.

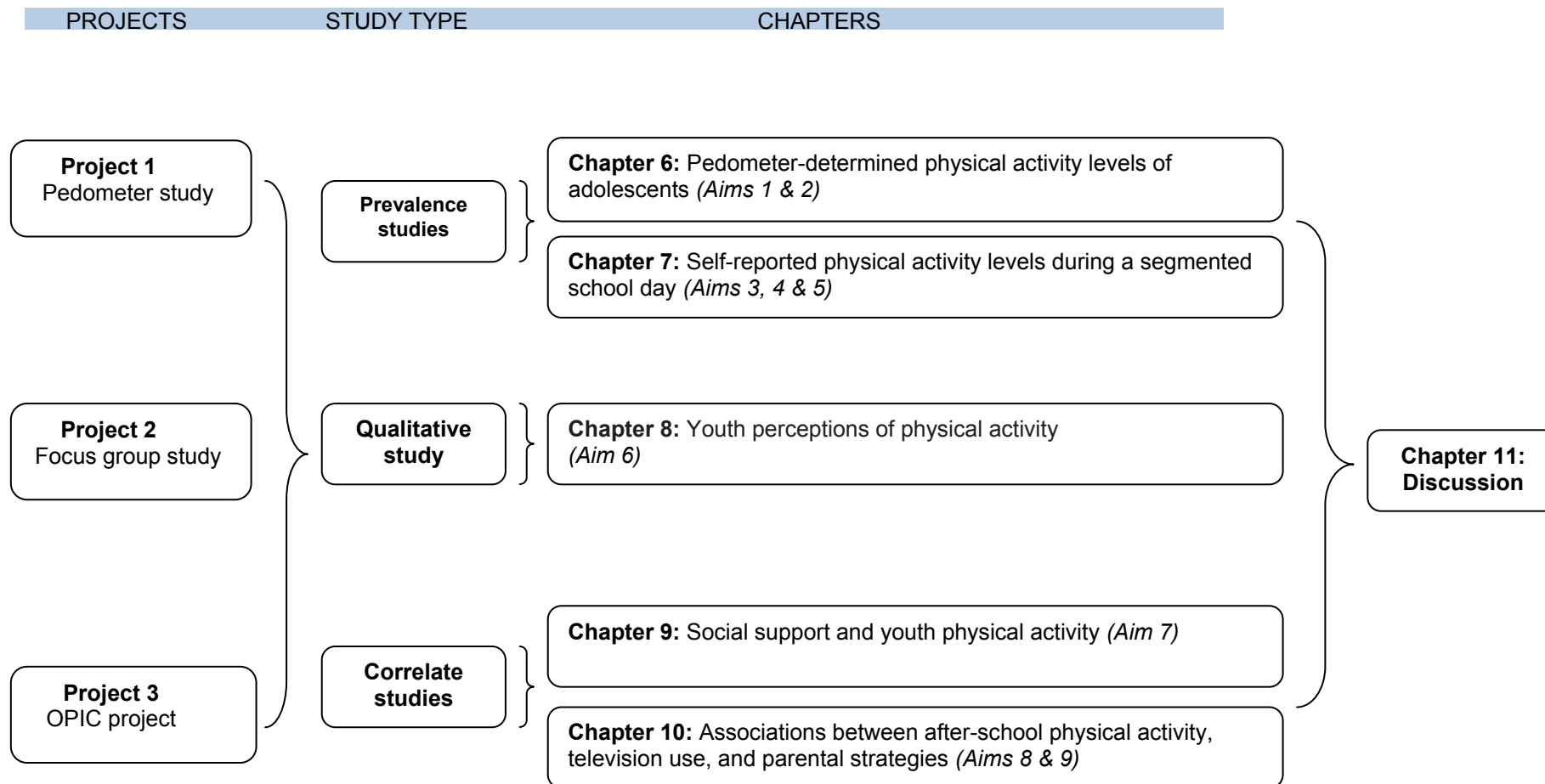


Figure 1: Illustration of the Thesis Structure

Study Objectives

Based on the data from the three research projects, the analyses presented in Chapters 6 to 10 were possible. The specific aims of each chapter are now presented.

Chapter 6

1. Examine daily step counts and make comparisons by age, sex, time of week, and mode of travel to and from school.
2. Determine the percentage of youth who met the 10,000-steps-per-day criterion by sex and age.

Chapter 7

3. Describe high school students' physical activity levels during four school-day physical activity opportunities (i.e., active travel, recess activity, lunchtime activity, after-school activity).
4. Determine the percentage of young people dichotomised as 'more active' (or 'less active') for each physical activity opportunity.
5. Determine the percentage of young people deemed 'more active' across all four school-day physical activity opportunities.
6. Investigate demographic and anthropometric variables associated with physical activity levels during the aforementioned school-day physical activity opportunities.

Chapter 8

7. Using an ecological framework, explore high school students' perceptions of physical activity according to sex and ethnicity. In particular perceived benefits of physical activity, the barriers to participating in various activity contexts (e.g., active transportation, physical education, lunchtime activity), and potential activity promoting strategies.

Chapter 9

8. Examine the relative importance of perceived encouragement from parents, older siblings/cousins, friends, and schools on participation in after-school physical activity, lunchtime physical activity, and engagement in active travel to and from school.

Chapter 10

9. Examine the association between self-reported after-school activity and weekday television (TV) use.
10. Investigate the association between differing levels of parental practices (e.g., presence/absence of physical activity encouragement, presence/absence of TV rules) on their child's school-day activity behaviours (e.g., levels of TV use and after-school physical activity).

Thesis Rationale

Target Population

There are justifiable reasons for focusing research attention across every phase of the human lifecycle. For several reasons, the focus of this thesis was on youth from low socio-economic backgrounds. International literature has indicated that a large proportion of youth are not sufficiently active, with declines in physical activity noted during the teenage years. Youth are growing up in a technology-saturated environment that is more likely to support a sedentary, low active lifestyle and provide numerous barriers to an active lifestyle. Today's adolescents are our future adults. Thus, directing intervention effort toward the youth population is vital if the burden of ill health during adulthood is to be reduced. Youth are also our future parents who will be key social influencers on future child and youth generations. Among youth, those of low socioeconomic status are a priority group because they have increased risk of poor health and low physical activity.

Despite the aforementioned reasons, in New Zealand (and in some instances internationally) less research attention has been directed toward the youth population group in comparison to the child (<12 years old) and adult populations. This has occurred despite adolescence being considered a critical development period associated with a reduction in physical activity engagement.

Physical Activity Measurement Tools

At the start of this thesis, no single field measurement tool had the ability to capture all dimensions by which physical activities can vary - duration, intensity, frequency, type, and context. The appropriateness of the

measurement tool(s) chosen therefore depends on the objectives of the research, the physical activity dimensions of interest, the characteristics of the target population (e.g., age), the size of the research sample as well as pragmatic considerations (e.g., data collection constraints, the availability of the method chosen, and funding accessibility).

When deciding on the physical activity tool for the OPIC project (of which the baseline data was used for Project 3 in this thesis) the following aspects of the OPIC project were considered. The OPIC project was targeting a large sample of students ($n > 4,500$), the main method of behavioural assessment was by questionnaire, identified intervention targets were active transportation, lunchtime physical activity, and after-school physical activity, and due to the limited length of the OPIC survey only a small number of physical activity questions could be incorporated. After considering these factors, physical activity across a segmented school day was assessed using four questions from the New Zealand Children's Nutrition Survey (Parnell, Scragg, Wilson, Schaaf, & Fitzgerald, 2003). These questions were considered the most appropriate for several reasons. First, the New Zealand Children's Nutrition Survey (CNS) was based on the Physical Activity Questionnaire for Children (PAQ-C) which has acceptable reliability and validity for use with children and adolescents (Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997; Kowalski, Crocker, & Faulkner, 1997a). Second, the survey questions followed a segmented day approach with several questions directly related to the physical activity aims of the OPIC intervention. Third, the question-based format aligned with the survey format of the overall OPIC project survey which, in addition to physical activity, assessed a number of other behavioural and environmental variables. Lastly, the physical activity questions were few in number allowing easy insertion into the overall OPIC survey.

Because of cost, administration burden, data collection constraints, and timing considerations, pedometers were not included as a tool for Project 3, but were used to collect physical activity data from the small sample of students in Project 1. The pedometer of choice was the NL-2000 because it displays high accuracy (within $\pm 3\%$ of actual step taken) and intra-model reliability (Crouter, Schneider, Karabulut, & Bassett, 2003; Schneider, Crouter, Lukajic, & Bassett, 2003) and has memory capacity to store seven consecutive days of data, thereby reducing both participant and researcher burden associated with daily

recording. While acknowledging the associated limitations of pedometers, pedometers do capture ambulatory activities that characterise the majority of children and young people's activity, in turn, allowing insight into the volume of daily activity levels. In addition to the pedometer, a self-report questionnaire regarding the main mode of travel to and from school was administered.

Significance of this Research

As outlined below, the content in this thesis adds to the current knowledge of physical activity and its determinants in three ways.

First, national and international knowledge about youth physical activity behaviours was based predominantly on survey-derived data, a measurement method associated with well-described limitations (Kohl III, Fulton, & Caspersen, 2000; Sirard & Pate, 2001; Welk, Corbin, & Dale, 2000a). Now, researchers endeavour to assess physical activity objectively. At conception of this thesis there were no published studies in New Zealand (and few studies internationally) that examined youth physical activity habits using an objective measure. Overcoming this gap, daily step counts (collected by pedometers) were collected from a sample of high school students that included all age groups represented at high school.

Second, while research shows young people tend to be more active on weekdays than weekend days (Klasson-Heggebo & Anderssen, 2003; Trost, Pate, Freedson, Sallis, & Taylor, 2000) the school day provides multiple opportunistic time periods for youth to be active. Schools also provide a structured environment in which targeted interventions could be implemented that reach the majority of the youth population, especially adolescents who are not likely to be active outside of the school environment. Although different domains of physical activity (e.g., sport, active transport) have been examined in international literature, they are often researched in isolation. As a consequence, the ability to determine if youth are maximising all opportunities available on a school day to be active is not possible. In this thesis, physical activity levels of high school students during four physical activity opportunities available within a school day were measured, namely, active travel to and from school, recess activity, lunchtime physical activity, and after-school physical activity. These data will help indicate if low socioeconomic positioned teenagers are maximising all opportunities available during a school day to be active. Also,

important time periods to target to maximise effectiveness and investments of intervention efforts can be potentially identified.

Third, ecological models posit that environments in close proximity to the individual will be the most influential (Spence & Lee, 2003). Thus, the relative importance of specific influencers is likely to differ across different physical activity contexts. Correlate-based research has focused on overall physical activity levels or intensity- defined physical activity (e.g., MPA, VPA) rather than context-specific activities (e.g., school related physical activity). From an ecologic perspective, the relative importance of significant others would differ depending on the context, domain, or type of activity examined. For this reason, potential influencers of specific physical activity opportunities (e.g., active travel, recess activity, after-school activity) were examined in this thesis rather than overall physical activity.

Collectively, the findings noted in this thesis will add to current knowledge of how active New Zealand high school students from low socioeconomic backgrounds are. As well, information about four time-specific physical activity opportunities and respective environmental correlates will be obtained. The findings will be of importance to both researchers and practitioners interested in reducing the level of physical inactivity among the youth population. The findings will have potential to inform future youth-focused initiatives and public health policy targeting improved physical activity, both in New Zealand and abroad.

Thesis Structure

This doctoral thesis consists of 11 Chapters. Chapter 1 sets the scene and briefly presents the reasons supporting the relevance of the research presented in this thesis. A broad overview of relevant physical activity literature, particularly youth-focused evidence, is presented in Chapters 2 through 5. Chapter 2 introduces fundamental components of physical activity research including definitions of key terms, health benefits afforded from an active lifestyle, and physical activity guidelines. Physical activity measurement tools are reviewed in Chapter 3. Physical activity levels from national, epidemiological evidence and objectively-determined data as well as participation rates in domain (e.g., sport) and time (e.g., physical activity during recess, after-school activity) specific activities are presented in Chapter 4. Chapter 5 provides an

overview of individual and environmental correlates of youth physical activity. While studies published prior to 2006 informed the questions examined in this thesis, the overview of literature has been updated to include studies published prior to 2008.

Based on the data collected for this thesis, five individual journal papers were produced and published (see page xix). Unlike traditional doctoral theses, Chapters 6 through 10 represent these five individual journal papers, with each paper presented in chapter style. Data collected in Project 1 formed the basis of the article presented in Chapter 6. Data collected from Project 2 formed the basis of the article presented in Chapter 8. The baseline data from the OPIC project (Project 3) formed the basis of the papers represented as Chapters 7, 9, and 10. Consequently, the information in these chapters regarding the methodology employed is unavoidably repetitive. At the beginning of each chapter, the preface provides justification for the objectives examined in the respective chapter.

The information contained in the Chapters 6 through 10 can be delineated into data pertaining to 'physical activity patterns' and 'correlates of physical activity'. In brief, these five chapters cover data on pedometer-determined physical activity levels (Chapter 6), physical activity levels during specific segments of a school day (Chapter 7), patterns of active transportation to/from school (Chapters 6 and 7), weekday TV watching patterns (Chapter 10), as well as individual and environmental influences of activity (Chapters 6 to 10). Collectively, these chapters answer the overarching thesis question - who, when, and why are a students from low-decile high schools active (or not)?

The final chapter (Chapter 11) draws together and summarises the key findings that emerged from the analyses conducted in the previous five chapters. Additional information not included in the chapters is located in the appendices.

Chapter 2: Fundamentals of Physical Activity Research

In sequential order, Chapter 2 presents an overview of:

1. the definitions for key physical activity terms;
2. the health benefits conferred through an active lifestyle; and
3. physical activity recommendations for children and young people.

Definitions of Key Terms

Physical Activity, Exercise, and Physical Fitness

Physical activity is often confused and used interchangeably with the terms 'exercise' and 'physical fitness'. While these three concepts share some common elements, clear distinctions exist. The widely accepted definition of physical activity proposed by Caspersen, Powell, and Christenson (1985) is "any bodily movement produced by skeletal muscles that results in energy expenditure". Exercise, however, is a subset of physical activity that is planned, structured, and repetitive, and carried out to maintain or improve at least one component of physical fitness (e.g., body composition, flexibility, agility, cardiorespiratory fitness). Physical fitness, therefore, is an attribute gained through being physically active whereas physical activity is the underlying behaviour (Caspersen et al., 1985).

Dimensions of Physical Activity

Physical activity is a complex behaviour that consists of activities that differ by type, duration, frequency, intensity, and context. Duration, frequency, and type are easily understood concepts. Duration refers to the length of time the activity is undertaken and is commonly expressed in minutes. Frequency describes how often the activity is performed and is typically assessed within a predefined period of time (e.g., during the past 7 days). The type of activity can be classified as aerobic, anaerobic, resistance, or weight bearing activity.

A more complex dimension is intensity. Intensity denotes the level of effort required to perform a specific activity and can be expressed in different ways. These expressions include: the number of kilocalories expended per minute ($\text{kcal}\cdot\text{min}^{-1}$) or as a metabolic equivalent (MET) value. The MET value refers to the energy expended relative to a person's metabolic rate. One MET refers to the energy expended by a person at rest, which equates to the

individual's metabolic rate. Two METs equate to double the amount of energy expended while at rest. The MET values associated with light, moderate, and vigorous intensity physical activity are < 3 METs, 3 to 6 METs, and > 6 METs, respectively (Sallis & Owen, 1999). With the use of activity compendiums (Ainsworth et al., 2000) that state MET values for several specific activities, survey-derived data can be converted into energy expenditure values. The level of energy expenditure associated with any specific physical activity is influenced by age, sex, fitness level, and weight. Thus, energy expenditure derived from survey data using activity compendiums and MET values is considered adequate for group level analyses, but caution is required when interpreting the finding for individuals.

A recently developed dimension of physical activity is the 'domain' (also referred to as 'context') in which physical activity is undertaken during day-to-day living. Four physical activity domains include: 1) occupation/school-related physical activity (e.g., farmer, recess-related physical activity, PE classes); 2) active travel (e.g., walking, cycling, skateboarding to work, school, or other destinations); 3) physical activity related to household/ domestic duties (e.g., housework, gathering food); and 4) leisure-time physical activity (LTPA) such as sport participation and active recreation (World Health Organization, 2002). Until recently, leisure-time physical activity was the primary indicator of physical activity in national monitoring systems. Consequently, population levels of physical activity were underestimated and individuals were potentially misclassified as active or inactive. Collecting domain-specific data is an important part of any national surveillance system because even in the absence of change in population levels of physical activity, a shift in the prevalence of domain-specific activities may occur.

Taxonomy of Physical Activity

For measurement purposes, physical activity is often partitioned into smaller, mutually exclusive and measureable subcategories. When combined, these subcategories provide an indication of total physical activity levels. Physical activity has typically been partitioned by intensity levels (e.g., time spent in moderate or vigorous intensity activity), and more recently by physical activity domains (US Department of Health and Human Services, 1996).

In this thesis, physical activity was partitioned in the following ways. In Chapter 6, physical activity was analysed according to the time of week (weekend step counts versus weekday step counts). In Chapters 7, 9, and 10 four opportunistic time periods that exist within a school day were examined. The four school-day physical activity opportunities were:

1. active travel to and from school;
2. morning recess physical activity participation;
3. lunchtime physical activity participation; and
4. after-school physical activity participation.

Taxonomy of Individuals - Physically Active, Inactive, and Sedentary

For the purpose of analyses, participants are often categorised into mutually exclusive physical activity groups. The term 'physically active' is often well understood and typically defined according to national physical activity guidelines (Tudor-Locke & Myers, 2001a). While internationally accepted physical activity guidelines exist for adults, the way in which the guidelines are operationalised is not consistent across national monitoring systems in various countries. This lack of consistency hampers the ability to directly compare national statistics between countries. For children and young people, these issues are exacerbated by the lack of internationally accepted physical activity guidelines. Even though many countries are adopting similar child and youth-specific guidelines, the way in which guidelines are operationalised is likely to differ between countries.

The terms 'physically inactive' and 'sedentary' are often used interchangeably thereby causing confusion regarding the measurement of the sedentary population. Tudor-Locke (2001a) referred to sedentary as low levels of total energy expenditure, time or distance walked, stairs climbed, and/or lack of self-report participation in sport and exercise. In the 2002 World Health Report titled 'Reducing Risks, Promoting Health' physical inactivity was defined as doing very little or no physical activity in any of the physical activity domains (World Health Organization, 2002). In recent years, sedentariness has been defined as the amount of time spent engaging with small-screen technology (e.g., TVs, videos, DVD's, computers, console games).

The confusion about the term 'sedentary' potentially lies in the dual application of this term to describe physical activity levels as well as sedentary

behaviours. Although 'physically active behaviours' and 'sedentary behaviours' can be characterised in terms of intensity, duration, frequency, type, and context of the activity undertaken, they do demonstrate differing tracking patterns (Janz, Burns, & Levy, 2005) and determinants (Brodersen, Steptoe, Williamson, & Wardle, 2005; Gordon-Larsen, McMurray, & Popkin, 2000; Schmitz et al., 2002) and also independently influence health risk (Atherton & Metcalf, 2006). These behaviours, therefore, are mutually exclusive and are not simply a mirror image or opposite ends of a continuum ranging from sedentary to physically active. Youth, therefore, can display varying levels of both sedentary and physical activity behaviours concomitantly. For instance, 'techno-active' youth display high levels of both physical activity and TV viewing/video game usage (Biddle, Gorely, Marshall, Murdey, & Cameron, 2003). Even though these behaviours co-exist within individuals they are often researched in isolation. Chapter 10 addresses this gap by examining the influence of parenting strategies on youth activity profiles. The activity profiles are based on both sedentary behaviours and physical activity behaviours.

Health Benefits Conferred Through an Active Lifestyle

It is well known that regular physical activity leads to an array of positive health outcomes for adults. These health benefits include reduced risk of coronary heart disease, hypertension, type II diabetes mellitus, obesity, certain cancers, and some mental health problems (Department of Health, 2004; US Department of Health and Human Services, 1996; World Health Organization, 2002). Comparatively, the empirical evidence linking health outcomes with adolescent physical activity, although ever-growing, is much less. Limited (or absence of) evidence does not necessarily signify that no significant relationships exist. Instead it supports the need for more investigatory research. Potential reasons underpinning the presence of weak associations between physical activity and health include a lack of variation among participants in terms of their physical activity level or the health outcome examined; factors other than physical activity may influence the presence or change in the health outcome (e.g., growth and maturation); and physical activity in its entirety is difficult to measure accurately among the child and adolescent population (Troost, 2005). Moreover, among the data that do exist, evidence has been drawn from predominantly cross-sectional studies or uncontrolled trials, with

randomised controlled trials remaining the exception rather than the rule (Trost, 2005). Despite the aforementioned limitations, it has been proposed that through partaking in physical activity during childhood and adolescence, young people can improve both their current health status as well as their health status during adulthood (Twisk, 2001).

Short-Term Health Benefits

Regular physical activity has been shown to exert several short-term benefits among young people. A recent review of literature conducted by an international panel of experts showed positive effects of physical activity and exercise on blood pressure among mildly hypertensive adolescents, high density lipoproteins, triglycerides obesity/adiposity, type II diabetes, skeletal health, and academic performance. Also, an inconsistent effect was noted for low density lipoprotein cholesterol, total cholesterol, asthma, cardiorespiratory fitness, and muscular strength. Because of research scarcity, an indeterminate effect on metabolic syndrome and mental health was reported (Strong et al., 2005).

Tracking of Physical Activity

Tracking of physical activity refers to the persistence of physical activity over time, for instance from childhood to adulthood. Tracking is a frequently stated rationale for focusing intervention effort toward improved physical activity behaviours among young people, especially children. Longitudinal prospective cohort studies such as the Young Finns Study (Telama et al., 2005), the Iowa Bone Development Study (Janz et al., 2005), the Muscatine Study (Janz, Dawson, & Mahoney, 2000), the Amsterdam Growth and Health Study (Kemper, Snel, Verschuur, & Storm-van Essen, 1990), and The Leuven Growth Study (Maia et al., 2001) have investigated whether physical activity tracks (or not). Despite differing methodologies employed (e.g., follow-up period, age group examined, physical activity tracking methods), significant, but weak tracking coefficients have been reported (Anderssen, Wold, & Torsheim, 2005). Stronger tracking coefficients have been reported over short follow-up periods rather than periods exceeding six years (Trost, 2005) and when the persistence of physical activity during adolescence has been examined (Tammelin, Nayha, Laitinen, Rintamaki, & Jarvelin, 2003; Telama et al., 2005). Findings from

Young Finns Study indicated that continuous physical activity during the school years substantially increases the likelihood of being active in adulthood. More specifically, participants who were constantly in the most active tertile of the physical activity index (PAI; assessed by survey) on two or three consecutive measurements over a six-year period during childhood and adolescence were at least 12.6 times more likely to be in the most active category during adulthood. When physical activity data from only two time points were examined (once in adolescence and once in adulthood), substantially lower odds ratios (range: 4.0 to 5.7) were found (Telama et al., 2005).

Determining the true magnitude of tracking is impeded by the scarcity of longitudinal studies, but also the relatively short, although pragmatically possible, monitoring timeframes often employed. Most longitudinal studies have directed attention to the time period from adolescence to young adulthood, with few studies tracking physical activity into late adulthood (e.g., post 40 years of age). Also, studies to date have typically examined the relationship between two cross-sectional data points taken once during adolescence and again in adulthood. As one data point may not accurately represent habitual physical activity during any single life phase (e.g., adolescence), the ability to find a strong tracking coefficient is weakened and the impact of persistence on future physical activity behaviours is also overlooked. More authoritative information on the phenomenon of tracking is likely to occur when studies implement multiple physical activity measurement tools (both objective and subjective), assess physical activity repeatedly, and if possible, employ direct replication of prior studies.

Impact on Future Adult Health

The impact of youth activity on adult health is less well understood. Over a short time period (e.g., from adolescent to age 40), favourable associations with bone mineral density (Barnekow-Bergkvist, Hedberg, Pettersson, & Lorentzon, 2006; Delvaux et al., 2001), adiposity (Tammelin, Laitinen, & Nayha, 2004), and some cancers (Lagerros, Hsieh, & Hsieh, 2004) have been reported. A recent prospective study on a Finnish birth cohort found that a reduction in physical activity levels during the transition period from adolescence to adulthood increased the likelihood of being overweight at age 31 (Tammelin et al., 2004). Also, based on a review of 19 case-control and four cohort studies,

Lagerros, Hsieh, & Hsieh (2004) concluded that each additional weekly hour of recreational physical activity during adolescence was associated with a 3% risk reduction of breast cancer in adulthood. Only longitudinal cohort prospective studies over a life course will provide further understanding of the impact adolescent activity has on adult health.

Activity Guidelines

Physical Activity Guidelines

Physical activity guidelines are consensus statements developed by relevant experts based on evidence linking physical activity (particularly exercise) with various health and behavioural outcomes (e.g., obesity, blood lipids, academic performance). During the past 50 years various organisations across the globe have advocated specific physical activity or physical fitness recommendations. These recommendations have evolved simultaneously with the growing evidence linking physical activity with health outcomes.

Early guidelines were directed towards improvement in cardiovascular fitness (CVF) and body composition. Such guidelines have been recently modified to encapsulate lifestyle physical activities required for health, rather than obtaining fitness *per se*. Highlighting this shift away from an exercise prescription model, the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) recommended 30 minutes of moderate intensity physical activity on most, but preferably on all, days of the week. Accumulating this recommended level throughout the day was also advocated (Pate et al., 1995). This 30-minutes-a-day guideline was further supported as a key recommendation for everyone over the age of two in the 1996 US Surgeon General's Report on Physical Activity and Health (US Department of Health and Human Services, 1996) with these guidelines recently clarified for the adult population (Haskell et al., 2007). The new lifestyle approach to physical activity informs people to gain health risk reduction through accumulated physical activity that can be more easily incorporated into their daily routine, thereby resulting in a more sustainable goal.

Physical Activity Guidelines for Children and Young People

Previous physical activity recommendations for children and young people tended to reflect adult guidelines. Obvious physiological differences

between childhood and adulthood were, therefore, dismissed. Studies linking health outcomes with youth physical activity are now more abundant with current guidelines for children and young people reflecting this emerging evidence. Specific physical activity guidelines for children and young people propounded since 1988 are presented in Table 1.

Key messages from current guidelines are that children and young people:

1. should engage in at least 60 minutes of moderate to vigorous physical activity (MVPA) per day;
2. can accumulate the recommended daily physical activity dose throughout the day;
3. are to engage in activities that are enjoyable and developmentally appropriate;
4. can gradually increase their physical activity to the minimum goal of 60 minutes, especially for youth who have been physically inactive; and
5. be active through play, games, sports, work, transportation, recreation, physical education, or planned exercise.

New Zealand recently adopted national physical activity guidelines for children and young people (Table 1). Aligned with other countries, the new guidelines produced in partnership by Sport and Recreation New Zealand (SPARC) and the Ministries of Health and Education recommend young people achieve at least 60 minutes of MVPA per day and partake in less than two hours of screen-use each day. The guidelines focus on accumulating physical activity throughout each day by engaging in different physical activity domains and environments (family, home, school, community).

Table 1: Examples of Physical Activity Recommendations for Children and Adolescents

Year Country	Author/Organisation	Document	Recommendation
1988 US	American College of Sports Medicine (ACSM)	Statement for physical fitness in children and youth (American College of Sports Medicine, 1988)	Obtain 20 - 30 minutes of vigorous exercise each day.
1994 International	Various	International Consensus Conference: Physical activity guidelines for adolescents (Sallis & Patrick, 1994)	All adolescents should be physically active daily, or nearly every day, as part of play, games, sports, work, transportation, recreation, PE, or planned exercise, in the context of family, school, and community activities. All adolescents should engage in three or more sessions per week of activities that last at least 20 minutes or more at a time and require moderate to vigorous levels of exertion.
1996 US	US Department of Health and Human Services	Physical Activity and Health: A Report of the Surgeon General (US Department of Health and Human Services, 1996)	At least 30 minutes of moderate intensity physical activity on most, if not all, days of the week.
1998 UK	Health Education Authority Symposium	Young and Active - Physical activity guidelines for young people (Biddle, Sallis, & Cavill, 1998)	Participate in physical activity of at least moderate intensity for one hour per day. Young people who currently do little activity should participate in physical activity of at least moderate intensity for at least half an hour per day. At least twice per week, some of these activities should help to enhance and maintain muscular strength and flexibility and bone health. Some of this physical activity should be of periods lasting 10-15 minutes or more and include moderate to vigorous activity. Extended periods of inactivity are discouraged for children. A variety of physical activity is recommended.
2002 Canada	Public Health Agency of Canada	Canada's guidelines for increasing physical activity in youth (Public Health Agency of Canada, 2002)	Increase time currently spent on physical activity, starting with 30 minutes or more per day (20 minutes of moderate activity and 10 minutes of vigorous activity). Reduce "non-active" time spent on T.V, video, computer games, and surfing the Internet, starting with 30 minutes or less per day. Build-up physical activity throughout the day in periods of at least 5 to 10 minutes.
2004 Australia	Department of Health and Ageing	Australia's physical activity recommendations for 12-18 year olds (Department of Health and Ageing, 2004)	Children and young people should participate in at least 60 minutes (and up to several hours) of MVPA every day. Children and young people should not spend more than 2 hours a day using electronic media for entertainment (e.g., computer games, Internet, television), particularly during daylight hours.

Table 1 Continued: Examples of Physical Activity Recommendations for Children and Adolescents

Year Country	Author/Organisation	Document	Recommendation
2004 UK	Department of Health, UK.	At Least Five a Week: Evidence of the impact of physical activity and its relationship to health (Department of Health and Ageing, 2004)	Children and young people should achieve a total of at least 60 minutes of moderate intensity physical activity each day. At least twice a week this should include activities to improve bone health, muscle strength, and flexibility.
2004 US	National Association for Sport and Physical Education	Physical Activity for Children: A Statement of Guidelines for Children Ages 5 - 12, 2nd Edition	Children should accumulate at least 60 minutes, and up to several hours, of age appropriate physical activity on all, or most days of the week. Children should participate in several bouts of physical activity lasting 15 minutes or more each day. Children should participate each day in a variety of age-appropriate physical activities designed to achieve optimal health, wellness, fitness, and performance benefits. Extended periods (periods of two hours or more) of inactivity are discouraged for children, especially during the daytime hours.
2005 Various	International Consensus Group of Experts	Evidence based physical activity for school-age youth (Strong et al., 2005)	School-aged youth should participate every day in 60 minutes or more of moderate to vigorous physical activity that is enjoyable and developmentally appropriate. For youth who have been physically inactive, an incremental approach to the 60-minute goal is recommended.
2006 US	Council on Sports Medicine and Fitness and Council on School Health	Active Healthy Living: Prevention of childhood obesity through increased physical activity (Council on Sports Medicine and Fitness and Council on School Health, 2006)	Limit screen time to <2 hours per day. Encourage children and adolescents to be physically active for at least 60 minutes per day, which may be accumulated by using small increments throughout the day. Events should be of moderate intensity and include a variety of activities for example, sports, recreation, transportation, chores, work, planned exercise, and school-based PE classes. Activities should be primarily unstructured and fun to achieve best compliance.
2007 NZ	SPARC, Ministry of Health, & Ministry of Education	No document. Guidelines available from www.sparc.co.nz	Throughout each day, do 60 minutes or more of moderate to vigorous physical activity. Be active in as many ways as possible; for example, through play, cultural activities, dance, sport and recreation, jobs, and going from place to place. Be active with friends and whānau, at home, school, and in the community. Spend less than two hours a day (out of school time) in front of television, computers and game consoles.

Even though guidelines are becoming more aligned across countries, the operationalisation of such guidelines are open to interpretations and can have an impact on prevalence estimates and one's ability to make cross-country comparisons. For example, among a sample of Australian 13 to 19 year olds, Olds et al (2007) found that, depending on how the guidelines were operationalised (e.g., meet the guideline on all days, most days of the week, average across all day, or the probability that a randomly selected young person meets the guidelines on a randomly selected day), the proportion of young people who met the Australian physical activity guidelines varied considerably in terms of compliance to the MVPA guideline (20% - 68%), screen guideline (12% - 42%) and both guidelines (2% - 26%). Moreover, different individuals were identified as compliant by the different methods of operationalisation. For national guidelines to be meaningful and comparable across countries, clarity on how guidelines are to be operationalised is required.

Building upon a lifestyle approach, preliminary step-based guidelines have been recently proposed for the adult (Tudor-Locke & Bassett, 2004), child (The President's Council on Physical Fitness and Sport, 2006; Tudor-Locke et al., 2004; Vincent & Pangrazi, 2002b), and youth (The President's Council on Physical Fitness and Sport, 2006) population groups (Table 2). Step-based guidelines provide an alternative to earlier recommendations that relied heavily on a structured sport and exercise perspective where time is set aside to be active. Guidelines targeting a daily step threshold cater to the importance of accumulating lifestyle physical activity throughout each day. Also, compared to time-based guidelines, step guidelines are potentially more easily understood by the layperson.

The most publicised step criterion - 10,000 steps-per-day (which is equivalent to expending 300 to 400kcal per day) - can be traced back to Japan over 30 years ago (Tudor-Locke & Bassett, 2004). Although frequently used by public and private health promotion organisations, a single generic guideline potentially creates an unreasonable or inappropriate goal for specific population groups who differ substantially in average daily step counts, for example, healthy children versus healthy older adults (Tudor-Locke & Myers, 2001b).

Table 2: Examples of Step-Based Physical Activity Recommendations

Age Group	Steps per day	Reference
Adults	<5,000 (sedentary) 5,000-7,499 (low active) 7,500-9,999 (somewhat active) ≥10,000 – 11,999 (active) >12,500 (highly active)	(Tudor-Locke & Bassett, 2004)
6 to12 yrs	11,000 (girls) 13,000 (boys)	(Vincent & Pangrazi, 2002b)
6 to 17 yrs	> 11,000 steps per day on at least 5 days	(The President's Council on Physical Fitness and Sport, 2006)
6 to12 yrs	15,000 (males) 12,000 (females)	(Tudor-Locke et al., 2004)

The aforementioned step-based guidelines for children are indeed proposed and preliminary as they are based on either a single health outcome (Tudor-Locke et al., 2004), norms from a small study sample (Vincent & Pangrazi, 2002b), or are largely arbitrary (The President's Council on Physical Fitness and Sport, 2006). While the proposed cut-points roughly equate to the 60 minutes of MVPA per day recommendation for children and youth (Cardon & De Bourdeaudhuij, 2004; Rowlands & Eston, 2005), caution is advised when interpreting these guidelines in terms of providing health outcomes. Further research is required to confirm or refute the proposed guidelines and ensure the development of efficacious and sustainable guidelines for the youth population that are based on multiple health outcomes and accurate criterion measures.

Recreational Screen-Use Guidelines

'Screen-use', 'entertainment media', 'electronic media', and 'small-screen technology' are frequently used and interchangeable terms. They all refer to the use of small-screen technology media (e.g., TVs, videos, DVD's, computers, console games). Substantial evidence indicates that small-screen technology use is associated with an increased risk of obesity and, to a lesser extent, reduced physical activity levels (Marshall, Biddle, Gorely, Cameron, & Murdey, 2004; Scragg, Quigley, & Taylor, 2006; Spinks, Macpherson, Baina, & McClurec, 2007; Tremblay & Willams, 2003). Accordingly, several countries including Canada (Public Health Agency of Canada, 2002), Australia (Department of Health and Ageing, 2004), and the United States (American Academy of Pediatrics, 1995) have incorporated screen-use recommendations

within their physical activity guidelines (Table 1). This appears to be a sensible and logical step considering the current climate of obesity among children and young people (McCarthy, Jarrett, Emmett, & Rogers, 2005; Turnbull, Barry, Wickens, & Crane, 2004; Werner & Bodin, 2007) and that a reduction in screen use may provide these individuals with free-time in which to choose more active pastimes (Epstein, Roemmich, Paluch, & Raynor, 2005).

The existing screen-use guidelines vary slightly across countries. Children in Australia are advised to spend no more than two hours per day using electronic media for entertainment (e.g., computer games, Internet, television), particularly during daylight hours. Similarly, American preschoolers, children, and adolescents are recommended to limit screen time to a maximum of two hours per day (American Academy of Pediatrics, 2001). A similar screen-use recommendation has been incorporated into the recently published national physical activity guidelines for children and young people in New Zealand.

Chapter 3: Measurement of Physical Activity

Valid, reliable, and practical measurement tools are required for the assessment of physical activity levels as well as to determine the efficacy of physical activity interventions. A plethora of physical activity instruments exist which individually can be categorised into one of the following three broad groups (Sirard & Pate, 2001): *criterion* (e.g., doubly labelled water), *secondary* (e.g., motion sensors), and *subjective* (e.g., questionnaires) measurement tools.

In Chapter 3 the following information is presented:

1. the challenges faced when measuring physical activity; and
2. an overview of specific criterion, secondary, and subjective measurement tools.

Challenges with Measuring Physical Activity

Accurate quantification of physical activity among children and young people is particularly challenging. Measurement challenges faced by researchers can be categorised as person-, behavioural-, or measurement tool-related challenges.

Person-related challenges refer to the characteristics of the population being assessed. When completing self-report surveys, humans display tendencies towards socially desirable responses as well as digit preferences of rounding numbers (DuBose, Cooper, Tudor-Locke, & Ainsworth, 2002). For young children, especially those below the age of 10 years, accurate recall is a key limiting factor of obtaining accurate survey-based information. Low cognitive ability and little cognisance of past behaviour, let alone intensity, duration, and context of the activity undertaken, all exacerbate this limitation (Sirard & Pate, 2001).

Behaviour-related challenges refer to the characteristics of the behaviour being examined, in this case physical activity. Even with robust tools, characterising physical activity levels is difficult because it is a relatively unstable behaviour that varies day-to-day, more so among adolescents than children (Troost et al., 2000). This is further complicated by the sporadic and intermittent nature of children's physical activity.

The lack of a gold standard tool is a key challenge. This is exacerbated by the lack of international consensus on a best practice approach for capturing physical activity, a criterion to define the term 'physically active', or how to operationalise existing physical activity recommendations. Whilst not international, a consensus approach for the measurement of physical activity in children and young people was developed as part of an Australian-based project (National Public Health Partnership, 2006).

This challenge of quantifying physical activity is compounded further by the various tools and the numerous units used to characterise physical activity. Examples of measurement/analyses units derived from the various measurement tools include:

- total physical activity;
- duration (e.g., total minutes or hours, time above a predefined activity threshold);
- energy expenditure (e.g., MET value);
- frequency of activity (e.g., bi-weekly);
- activity counts (e.g., average activity counts);
- step counts (e.g., total over predefined monitoring period (e.g., day, week), average step counts per day);
- beats per minute (bpm);
- oxygen consumption (e.g., Vo_2 max (ml.kg.min⁻¹));
- ordinal classifications (e.g., light, moderate, and high activity or sedentary, insufficiently active, and highly active); and
- dichotomised classifications (e.g., active and inactive).

An overview of the key attributes of commonly employed tools is presented in Table 3.

Table 3: Synopsis of Key Attributes for Current Methods to Measure Physical Activity in Children and Adolescents.

Method	Output	Valid	Objective	Inexpensive	Easy to administer	Easy to complete	Various dimensions of physical activity captured	Feasible for large studies	Non-reactive
SUBJECTIVE									
Questionnaire_SR	Measure dependent	✓	X	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Questionnaire_I	As above	✓✓	X	✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓
Proxy report	As above	✓	X	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Diary	As above	✓	X	✓✓✓	✓✓	✓✓	✓✓✓	✓✓	✓
SECONDARY									
Heart rate monitoring	Heartbeats	✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓
Accelerometers	Counts	✓✓	✓✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓✓
Pedometers	Steps	✓✓	✓✓✓	✓✓✓	✓✓	✓✓	✓	✓✓	✓✓
CRITERION									
Direct observation	EE	✓✓✓	✓	X	✓	✓✓✓	✓✓✓	X	✓
Doubly labelled water	EE (kcal)	✓✓✓	✓✓✓	X	✓	✓✓	X	X	✓✓✓

✓✓✓Excellent; ✓✓ Moderate; ✓ Low; X Poor/inappropriate; SR = Self report; I = Interview administered

Criterion Measurement Tools

Criterion measurement tools can be grouped into one of two categories: laboratory-based (e.g., direct calorimetry, whole room indirect calorimetry) or field-based (e.g., direct observation, indirect calorimetry, doubly labelled water). Criterion tools provide accurate quantification of energy expenditure and/or physical activity, but the extremely controlled nature of laboratory methods limits the application to assessing free-living physical activity. In contrast, field-based tools allow the measurement of physical activity (or energy expenditure) in a naturalistic setting. Utilising criterion measures in large sample or population studies is hampered by their associated cost and complexities. Criterion measurement tools should be used as validation measures against which newly developed field-based measures should be compared (Sirard & Pate, 2001).

Direct calorimetry, indirect calorimetry, and doubly labelled water are all criterion measures that estimate energy expenditure. Put simply, direct calorimetry involves the direct measurement of heat produced by an individual who is enclosed within a thermally insulated small chamber. Water is circulated around the chamber, with changes in water temperature allowing heat production to be measured. Direct calorimetry, while valid and accurate, has limited application in assessing free-living physical activity. This method is also expensive, time-consuming, and requires technical expertise to conduct (Sirard & Pate, 2001).

Using a spirometer, indirect calorimetry estimates energy expenditure by measuring oxygen consumption and carbon dioxide production in inspired and expired air (Sirard & Pate, 2001). Two variations of indirect calorimetry are closed-circuit spirometry and open-circuit spirometry. While less expensive than direct calorimetry and doubly labelled water, indirect calorimetry shares similar limitations when assessing free-living activity. It measures energy expenditure rather than physical activity *per se*, can be costly, technical expertise is required, and the portable gas systems are not user-friendly when assessing physical activity over long time periods (Sirard & Pate, 2001).

Doubly labeled water (DLW) is water which has been labeled with radio-labeled isotopes, deuterium (^2H) and ^{18}O . After consumption, deuterium is eliminated from the body as water and ^{18}O is eliminated as water and CO_2 . The difference in elimination rates of the two isotopes provides an indication of CO_2 output which is then used to calculate energy expenditure via standard

equations (Ainslie, Reilly, & Westerterp, 2003; Schoeller, 1999). Unlike calorimetry, doubly labelled water provides an accurate measure of total energy expenditure of participants under their normal living conditions (Ainslie et al., 2003; Schoeller & van Santen, 1982) without mechanical restriction. Thus, this accurate and noninvasive method is considered the preferred method for assessing energy expenditure in both healthy and clinical populations (Schoeller, 1999). In addition to total energy expenditure, physical activity-related energy expenditure can be calculated if the person's metabolic rate is known. As this method is a valid measure of total energy expenditure (Ainslie et al., 2003; Schoeller, 1999; Sirard & Pate, 2001), it has been applied to various population groups across the life course, including adults (Trabulsi et al., 2003), children (Ekelund et al., 2001; Hoos, Plasqui, Gerver, & Westerterp, 2003; Johnson, Russ, & Goran, 1998), and youth (Arvidsson, Slinde, & Hulthen, 2005; Bratteby, Sandhagen, Fan, Enghardt, & Samuelson, 1998), especially as a validation tool. The doubly labelled water method is limited by the expense of the isotopes, in turn, reducing its application in large scale studies. While diet induced thermogenesis can be estimated, accurate nutritional intake records over the entire monitoring period is preferred. Even though it can be used under habitual conditions, only total energy expenditure can be calculated. Other key dimensions relevant to population-level physical activity research, such as duration, intensity, frequency, or intensity dimensions of physical activity cannot be captured (Sirard & Pate, 2001).

While more mobile noncriterion alternatives are being developed to measure energy expenditure in the field, the validity and reliability of such devices are poor. For example, the SenseWear Pro2 Armband collects multiple sensory information from the skin temperature sensor, nearbody temperature sensor, heat flux sensor, galvanic skin response sensor and a biaxial accelerometer comprising the armband. The information from the sensors combined with demographic information (i.e., sex age, height, weight) is incorporated into proprietary algorithms to estimate energy expenditure. Arvidsson and colleagues (2007) reported that the SenseWear Pro2 Armband underestimate energy cost of most activities undertaken by a sample of children aged 11 to 13 years old. Activities examined in this study included resting energy expenditure, lying, sitting playing games on a mobile phone, stepping up and down on a step board, stationary bike cycling, jumping on a trampoline,

playing basketball, and walking/running on a treadmill at different speeds. Furthermore, increases in the underestimation of energy cost occurred with increased physical activity intensity. Of interest to researchers estimating energy expenditure among children, the authors provided a table of child-specific MET values for different physical activities measured by indirect calorimetry. Although limited, it is a starting point for the creation of a child-specific compendium of activity-related intensities.

Amongst the criterion tools, direct observation provides the most practical and appropriate measure to assess physical activity levels and patterns of children (Sirard & Pate, 2001). Direct observation involves a trained observer to watch and record physical activity behaviours of a particular individual within a naturalistic setting for a predefined period of time. Particular characteristics of the behaviour are typically recorded using momentary time sampling with time intervals that can range from five seconds to one minute (Troost, 2005). Several direct observation systems exist which have differing protocols (e.g., environment monitored, activity categories, recording intervals). Examples of direct observation tools include: *SOFIT* - System for Observing Fitness Instruction Time (McKenzie, Sallis, & Nader, 1992), *SOPLAY* - System for Observing Play and Leisure Activity in Youth (McKenzie, Marshall, Sallis, & Conway, 2000), and *CARS* - Children's Activity Rating Scale (DuRant et al., 1993).

Although dependent on the protocol, direct observation can provide a valid and reliable method for measuring physical activity in children, despite the intermittent nature of their activity (Sirard & Pate, 2001). Some direct observation systems allow environmental factors (e.g., presence of others, equipment availability) to be captured, making these systems a useful tool for researchers and practitioners alike (Troost, 2005). Despite these advantages, the direct observation method has several limitations. In addition to the necessity of trained observers, such systems can be labour intensive in terms of both data collection and analysis. The application of direct observation to large scale population level studies is, consequently, limited. Pragmatic restrictions on length of observation can hamper the ability to assess total daily or weekly activity levels. The potential for participant reactivity can be minimised by increasing familiarity of the observer with participants through repeated observations. Lastly, if energy expenditure is the outcome of interest, more valid

estimates are obtained through doubly labelled water and indirect calorimetry methods (Sirard & Pate, 2001; Trost, 2005).

Secondary Measures

Heart Rate Monitors

Heart rate monitors objectively measure a physiological response of physical activity - heart rate. These monitors consist of a chest mounted transmitter belt that measures then transmits the number of heart beats per minute (bpm) to a receiver device (e.g., a watch). Depending on the model, the sampling frames range between 15 seconds to 1-minute intervals with capacity to store up to several days of data. Through monitoring an individual's heart rate, the frequency, intensity, and duration of movement can be examined.

The output of heart rate monitors (bpm) is typically analysed by determining the number of minutes above a certain percentage of maximal heart rate, heart rate reserve (HR_{\max} minus HR_{rest}), or FLEX heart rate. These procedures estimate the amount of time activity is undertaken at varying intensities which, in turn, can then be used to estimate energy expenditure. The heart rate reserve (HRR) and FLEX heart rate methods allow comparisons between people with different fitness levels, with the FLEX heart rate method providing the best estimate of energy expenditure (Freedson & Miller, 2000).

While frequently used as a validation tool, several noted limitations of heart rate monitoring precludes its ability in predicting physical activity accurately, especially when used in isolation (Maas, Kok, Westra, & Kemper, 1989; Rowlands, Eston, & Ingledew, 1997; Trost, 2005). It is not a direct measure of physical activity or energy expenditure (Rowlands et al., 1997). A key assumption underlying this method is that a linear relationship between heart rate and maximal oxygen uptake (VO_2) exists. Although this relationship holds true during steady state dynamic exercise, the robustness of the relationship decreases when activities occur at low intensities and during static activities (Freedson & Miller, 2000; Maas et al., 1989). The heart rate - VO_2 relationship is also influenced by the size of the muscle in use, type of muscle contraction, and fitness level of the individual. In particular, at a similar submax VO_2 , a higher heart rate is elicited by small

muscles (e.g., arms) than large muscles (e.g., legs), during isometric contractions than dynamic contractions, and for those individuals who are less physically fit (Montoye, Kemper, Saris, & Washburn, 1996; Rowlands et al., 1997; Saris, Binkhorst, & Cramwinckel, 1980). Furthermore, a change in heart rate may occur for reasons other than body movement, reasons that are outside the control of the individual and researcher. In particular, high ambient temperature, high humidity, fatigue, hydration level, and emotional stress may affect an individual's heart rate in the absence of a significant rise in oxygen consumption (Freedson & Miller, 2000; Melanson & Freedson, 1996; Montoye et al., 1996). Also, there tends to be a delay between changes in physical activity and heart rate response. Thus, monitoring heart rate may camouflage the sporadic activity patterns children typically display (Rowlands et al., 1997; Trost, 2005).

Overall, heart rate monitoring can be time consuming and invasive (due to wearing a transmitter daily). Heart rate can be influenced by factors other than physical activity thereby leading to increased error of measurement. Consequently, heart rate monitoring may not be the most appropriate method to accurately reflect physical activity levels or patterns among children and youth. Recent technological developments indicate that motion sensors may provide an alternative and more accurate method to assess physical activity and energy expenditure (Eston, Rowlands, & Ingledew, 1998).

Motion Sensors

Pedometers, uniaxial accelerometers, and triaxial accelerometers are all examples of currently employed motion sensors that range in cost and complexity. Motion sensors are gaining popularity as the most appropriate tool to assess habitual, free living physical activity among children and young people. This class of tool overcomes the inherent recall errors associated with traditional questionnaires as well as the prohibitive costs and impracticalities associated with criterion instruments. The accuracy of physical activity levels based on motion sensor data is dependent on the length of time participants wore the pedometer or accelerometer. Wearing time is typically assessed with a self-report compliance form, thereby limited

by the subjective nature of the time reported. However, motion sensors provide the best cost - accuracy trade-off among currently available tools.

To assess habitual physical activity, a minimum monitoring frame of four days has been suggested, with increased accuracy obtained with longer collection periods, for example, up to seven days (Janz, Witt, & Mahoney, 1995; Rowe, Mahar, Raedeke, & Lore, 2004; Strycker, Duncan, Chaumeton, Duncan, & Toobert, 2007; Trost et al., 2000) and the inclusion of weekend days and weekdays (Rowe et al., 2004). Project objectives and pragmatic considerations such as compliance, available resources, and timelines (Bassett et al., 1996; Schneider et al., 2003; Tudor-Locke, Williams, Reis, & Pluto, 2002b) often drive the monitoring frame employed.

Accelerometer An accelerometer is a small electronic device that consists of a piezoelectric sensor. With body movement, the piezoelectric sensor bends/strains proportionally to the force or level of acceleration. A key theoretical assumption of accelerometers is that the accelerations measured are directly proportional to the muscular force produced and, in turn, energy expended (Melanson & Freedson, 1996). Depending on the model, accelerations can be measured across the vertical, anterior-posterior, and/or medio-lateral planes of movement (Freedson & Miller, 2000). Measuring accelerations along all three planes, triaxial accelerometers provide the best estimate of physical activity levels among children (Eston et al., 1998).

Accelerometers are typically worn at hip level, however, some models can be placed on other body articulations (e.g., wrist, ankle). The output of an accelerometer is activity counts per unit of time per axis measured. To date, the output has been analysed as total daily counts, daily averages, counts per minute, or translated into intensity-related activity categories which are based on predefined count thresholds.

Accelerometers collect rich data on the frequency, intensity, and duration of a wide range of physical activities. The internal clock mechanism allows activity levels during specific time periods (e.g., after-school) to be assessed. Recently developed accelerometers have shorter epochs (e.g., 1-sec) and memory capacity that allows collection and storage of data over several sequential days. Downloading capabilities provide a fast and efficient transfer of data from accelerometer to computer.

The utility of accelerometers for assessing free living physical activity among adults, children, and youth is widely accepted among the research community. Among children and youth, the Tritrac, Actiwatch, and CSA accelerometers have achieved acceptable validity coefficients with various criterion and secondary measurement tools. The CSA accelerometer also demonstrates high inter-instrument reliability. Table 4 provides presents findings from a selection of studies assessing the reliability and validity of various motion sensors.

Like all tools, accelerometers do have some limitations. Accelerometers have an inability to sense change in energy costs associated with upper body movement, differences in load (e.g., carrying groceries), change in terrain type (e.g., walking on hard versus soft surfaces, incline of walking surface) or grade (flat ground versus incline) (Hendelman, Miller, Baggett, Debold, & Freedson, 2000; Melanson & Freedson, 1995; Troutman, Allor, Hartmann, & al., 1999). Consequently, accelerometers typically underestimate energy expenditure compared to criterion tools (Bassett, 2000; Hendelman et al., 2000; Welk et al., 2000a). Thus, estimating energy expenditure from count data, while considered appropriate for group-level analysis, is not appropriate for individual-level analysis unless calibration of the accelerometer with energy expenditure for each individual is undertaken. Energy expenditure prediction equations developed for adults do not account for the developmental differences in resting metabolic rate of children, nor the poor economy of movement among children and adolescents relative to their adult counterparts (Troost, Way, & Okely, 2006). Accordingly, child- and adolescent-specific energy expenditure prediction equations are required.

From a practicality standpoint, accelerometers are expensive to purchase, around US\$500 per unit (de Vries, Bakker, Hopman-Rocka, Hirasanga, & van Mechelen, 2006). Also, technical expertise is required to download and analyse the raw data, thereby limiting their applicability in nonresearch communities.

Table 4: Psychometric Properties of a Selection of Secondary Measures in Children and Youth

Model	Reliability	Validity		Age (yrs)	Reference
		Criterion tool	Coefficient		
Uniaxial Accelerometers					
Caltrac	r = 0.89 (left versus right hip position) r = 0.73-0.80 (7 to 13 days test-retest) r = 0.96 (inter-instrument)	Energy expenditure video	r = 0.95	15.2 (mean)	(Ballor, Burke, Knudson, & al., 1989)
		VO ₂	r = 0.66-0.93	8-16	(Sallis, Buono, Roby, Carlson, & Nelson, 1990; Troutman et al., 1999)
		Heart rate monitoring	r = 0.28-0.54	8-13	(Allor & Pivarnik, 2001; Sallis et al., 1990)
		Interviewer-administered self-report	r = 0.49-0.39	8-13	(Sallis et al., 1990)
		Direct calorimetry	r = 0.11-0.87		(Bray, Wong, Morrow, Butte, & Pivarnik, 1994)
		Doubly labelled water	r = 0.09-0.22	6-11	(Johnson et al., 1998)
		Indirect calorimetry	r = 0.22-0.72	11.4 (mean)	(Eisenmann et al., 2004b)
Actiwatch		Direct calorimetry	r = 0.78-0.80	6-16	(Puyau, Adolph, Vohra, & Butte, 2002)
		Heart rate monitoring	r = 0.66-0.67	6-16	(Puyau et al., 2002)
		Accelerometer (CSA)	r = 0.82-0.89	6-16	(Puyau et al., 2002)
CSA	r = 0.87 (left versus right hip position)	Indirect calorimetry	r = 0.50-0.88	8-14	(Eston et al., 1998; Louie, Eston, Rowlands, & al., 1999; Trost et al., 1998) (Eisenmann et al., 2004b)
		Heart rate monitoring	r = 0.50-0.77	6-16	(Eston et al., 1998; Janz, 1994; Puyau et al., 2002; Trost et al., 1998)
		Pedometer	r = 0.47	8-9	(Treuth et al., 2003)
		Direct observation	r = 0.50	13.3 (mean)	(Benefice & Cames, 1999)
		Doubly labelled water	r = 0.39-0.58	9.1 (mean)	(Ekelund et al., 2001)
		Direct calorimetry	r = 0.66-0.73	6-16	(Puyau et al., 2002)
		Actiwatch accelerometer	r = 0.82-0.89	6-16	(Puyau et al., 2002)

Table 4 Continued: Psychometric Properties of a Selection of Secondary Measures in Children and Youth

Model	Reliability	Validity		Age (yrs)	Reference
		Criterion tool	Coefficient		
Triaxial Accelerometers					
Tritrac®		HRM	r = 0.34 -0.91	5-15	(Coleman, Saelens, Wiedrich-Smith, Finn, & Epstein, 1997; Eston et al., 1998; Welk & Corbin, 1995) (Rodriguez et al., 2002)
		Gas analysis	r = 0.74 -0.94	8-10	
		Direct observation	r = 0.70-0.77	10-12	
		Caltrac	r = 0.86	11.2 (mean)	
RT3		Indirect calorimetry	r = 0.82-0.89	9.5 (mean)	(Crocker, Holowachuk, & Kowalski, 2001)
					(Rowlands, Thomas, Eston, & Topping, 2004)

Prior to analysing the count data, relatively arbitrary judgements need to be made which ultimately influence the data composition and subsequent findings. First, the epoch length (i.e., time period over which the activity counts are collected, aggregated, with the averaged value stored for data analysis) or sampling interval (i.e., storing activity counts at specific time intervals: 1 second, 10 seconds) needs to be determined. A one minute epoch, a length commonly employed, has been reported to underestimate MVPA (Nilsson, Ekelund, Yngve, & Sjostrom, 2002) because it lacks the ability to capture the intermittent nature of childhood physical activity. The researcher's choice of epoch is influenced by the capacity of the available accelerometer (e.g., memory options) as well as objectives of the research. Second, decisions regarding the inclusion and exclusion criteria for the count data are required. Such criteria relate to the minimum duration for which activity counts must be obtained per day (e.g., 8 hours) and the threshold to determine whether the monitor had been removed (e.g., no activity counts recorded over a continuous 20 minute period). The minimum number of collection days (e.g., four days) for participants must also be decided. The exclusion rate and representativeness of the final dataset will be influenced by the aforementioned decisions.

A major limitation of accelerometers relates to the uncertainty surrounding the interpretation and translation of the raw data collected. To obtain meaningful information from count data, energy expenditure predictions equations have been developed and count thresholds that reflect differing intensities (e.g. sedentary, moderate, and vigorous) have been determined. To date, several different thresholds and equations have been proposed (Freedson, Melanson, & Sirard, 1998; Puyau et al., 2002; Reilly et al., 2003; Trost et al., 2002a), with examples presented in Table 5. Although several options exist, no standardised protocol of analysis does. Consequently, inconsistent methodologies have been employed to date.

Table 5: Examples of Youth-Specific Accelerometer Count Thresholds and Prediction Equations

Reference	Intensity-specific count thresholds				Units	n	Sample Characteristics	
	Sedentary	Light	Moderate	Vigorous			Age (yrs)	Accelerometer model
(Treuth et al., 2004)	0-50	51-1499	1500-2600	>2600	counts.30s ⁻¹	74	13-14	Actigraph
(Puyau et al., 2002)	< 800	< 3200	< 8200	≥ 8200	counts/minute	26	6-16	CSA
(Puyau et al., 2002)	< 100	< 900	< 2200	≥ 2200	counts/minute	26	6-16	Mini Mitter
(Riddoch et al., 2004)			~ 1000					
Energy Expenditure Prediction Equation					Units	n	Age	Accelerometer model
(Trost et al., 1998)	EE = -2.23 + 0.0008(cpm) + 0.08(body mass(kg))				kcal/min	30	10-14	CSA
(Freedson et al., 1997)	METS = 5.6832+ 0.00093(cts/min) - 0.2613(age in yrs)				MET value	80	6-17	CSA
(Freedson et al., 1998; Trost, Kerr, Ward, & Pate, 2001; Trost et al., 2002a)	METS = 2.757 + (0.0015 x cpm) – (0.08957 x age (yr)) – (0.000038 x cpm x age(yr))				MET Value	50 80	Adults 6-18	CSA CSA
(Puyau et al., 2002)	AEE = 0.0183 + 0.000010(cmp)				kcal/kg/min	26	6-16	CSA/ Mini Mitter

Child and adolescent specific prediction equations of energy expenditure account for differences in metabolic rate and movement efficiencies of children relative to adults. These equations were originally validated within controlled laboratory settings with differing sample characteristics. Noting these limitations, Trost, Way, and Okley (2006) recently cross-validated the Trost (Trost et al., 1998), Puyau (Puyau et al., 2002), and Freedson (Freedson et al., 1998) prediction equations among 45 healthy children and adolescents during over-ground walking and running conducted in an exercise facility. The Puyau and Freedson equations accurately predicted energy expenditure during slow walking and fast, respectively. No equation accurately predicted brisk walking-related energy expenditure. Accuracy of classifying activity intensity ranged from fair to excellent with the Trost equation demonstrating the highest classification accuracy and the Puyau equation exhibiting the lowest. Considering the Puyau equation was developed on energy expenditure measurements during several activities, not just walking and running (as assessed by Trost, Way and Okley (2006)), this methodological discrepancy may underpin the aforementioned poor result reported for the Puyau equation. Being developed on a variety of activities, the Puyau equation may provide a more accurate estimate of daily energy expenditure. Whilst the prediction equations for estimating energy expenditure were not accurate, Trost et al (2006) concluded that the equations could be useful for estimating intensity classifications. Noting the current limitations, alternative approaches of analysis are warranted. One alternative method is to characterise activity behaviour based on acceleration patterns rather than count thresholds (Freedson, Pober, Janz, 2005).

Pedometers Pedometers are small digital devices typically worn on the hip at waist level. They record steps taken as a result of a spring-suspended pendulum or a piezoelectric sensor being triggered by body displacement (e.g., hip acceleration). Compared to accelerometers, pedometers provide a less expensive and, therefore, more plausible alternative for gathering objective physical activity data. Unlike accelerometers, pedometers provide a simple, easily understood output (i.e., step) that shares common currency across age groups. Several models of pedometer are commercially available. Depending on brand, pedometers have demonstrated high step counting accuracy and provide a

valid option for assessing physical activity among both children and adults (Barfield & Rowe, 2004; Eston et al., 1998; Kilanowski, Consalvi, & Epstein, 1999; Tudor-Locke et al., 2002b).

Among the current models, the Digiwalker SW-series pedometers (Yamax) and the NL-2000 pedometer (New Lifestyle Inc) have been used extensively for research purposes. For the child population, the Digiwalker pedometers have achieved moderate to high validity coefficients with various objective criterion measures (Eston et al., 1998; Kilanowski et al., 1999; Louie et al., 1999; Saris & Binkhorst, 1977; Scruggs et al., 2003) in both laboratory and field situations (Eston et al., 1998; Scruggs, Beveridge, Watson, & Clocksin, 2005). As expected, step counts have been found to correlate poorly with various survey-derived physical activity levels ($r = 0.04$ to 0.21), with a slightly higher coefficient ($r = 0.28$) noted with 7-day recall diary data (Strycker et al., 2007). High inter-instrument reliability (Beets, Patton, & Edwards, 2005; Scruggs et al., 2003) and test-retest reliability (Strycker et al., 2007) with coefficients above 0.70 have been reported. Among adults, the NL-2000 and Digiwalker SW-701 pedometer were shown to be the most accurate models displaying step values that were within $\pm 3\%$ of the actual steps taken, 95% of the time (Schneider et al., 2003).

For epidemiological research, ensuring low reactivity (i.e., the level of change in an individual's behaviour as a result of wearing a pedometer or seeing their step counts) is important. Pedometers appear not to be associated with reactivity among the child population, irrespective of whether the pedometer was sealed or not (Rowe et al., 2004; Vincent & Pangrazi, 2002a). If reactivity was to occur, it is likely to take place during the first day of use. Considering the first day is the day of pedometer distribution, it is often excluded from analyses. Hence, the chance of obtaining outlier data is reduced.

Walking speed as well as pedometer placement and tilt can influence step count accuracy. Speeds slower than $80\text{m}\cdot\text{min}^{-1}$ have been shown to substantially increase the margin of error in recorded step counts among adults (Crouter et al., 2003). An underestimation of step counts was observed among children walking $54\text{m}\cdot\text{min}^{-1}$ or slower (Beets et al., 2005). The Digiwalker DW-500 pedometer was found to display enhanced step-count accuracy at low to moderate walking speeds and across different walking surfaces among adults (Bassett et al., 1996). In terms of placement and tilt of a pedometer, ankle and

waist mounted pedometers display superior validity than those placed at the wrist (Eston et al., 1998; Louie et al., 1999). Compared to the spring-levered Digiwalker SW-200, the recently developed piezoelectric pedometer, the NL-2000, is less sensitive to positioning, tilt, waist circumference, and body mass index, in turn, yielding more accurate step counts in overweight and obese individuals. This was particularly apparent at slower walking speeds (Crouter, Schneider, & Bassett, 2005).

While associated with several advantages, several factors limit the ability of pedometers to assess free-living habitual activity. Pedometers only measure volume of activity and not duration, intensity, frequency, or type of free-living activity. Thus, it is not possible to determine the percentage of people meeting current national physical activity guidelines with pedometers. Based on minimal information (e.g., age, sex; stride length) entered into the pedometer by the individual, some pedometers calculate distance walked or total caloric expended. Because pedometers cannot detect differences in stride length or energy expenditure that occur as a response to varying terrain, the estimations of distance walked and total caloric expenditure are associated with large measurement error. Furthermore, pedometers are designed to measure only ambulatory movement; movement that underpins the majority of children's activity. However, other nonambulatory but child-relevant activities (e.g., swimming) as well as isometric activities are also not captured.

Prior to the development of the NL-2000 pedometer, pedometers lacked data storage capacity and an internal clock function. Consequently, recording daily step counts or step counts during certain segments of the day (e.g., before school and at lunchtime) could not occur without human intervention, thereby resulting in increased participant and/or researcher burden. Because of its internal clock and data storage capacity, the NL-2000 pedometer, which was used for the research presented in this thesis, has the ability to store total step counts at one-day epochs for a total of seven days.

Despite the aforementioned limitations, researchers can have confidence that the scores obtained from the Digiwalker pedometers are accurate (Vincent & Sidman, 2003). The NL-2000 pedometer also shows promise.

Whenever possible, the use of accelerometers and pedometers to assess free-living physical activity is desirable as these practical and relatively easy to implement tools provide unbiased, rich physical activity data. These

methods overcome the high cost associated with laboratory-based instruments and the subjective nature of self-report methods. They demonstrate adequate sensitivity to measure incidental and moderate intensity physical activity, two important concepts directly related to current lifestyle-focused physical activity guidelines. Technology is continually evolving with new devices incorporating various aspects of different secondary measures. Combining techniques into a single device or using multiple measures concomitantly to assess physical activity reduces the limitations associated with any single method while also allowing data triangulation.

Subjective Measures

Measurement Tool Type

Using questionnaires, respondents are asked to recall their physical activity over a set period of time, with the recall timeframe ranging from one day to 12 months. Interviewer, computer, and self-administered questionnaires, proxy reports, and recall diaries are all examples of subjective measurement tools that share well documented advantages and limitations (Bjornson, 2005; Kohl III et al., 2000; McCormack & Giles-Corti, 2002; Sallis & Saelens, 2000; Sirard & Pate, 2001; Welk et al., 2000a). Over the years, researchers have developed and validated several subjective tools, each employed to varying degrees in child and youth physical activity research. Instruments are unique in the approach used, the dimensions of physical activity captured, and recall timeframe employed.

Without doubt, questionnaires are the most commonly employed tool to measure and survey physical activity across the human lifespan. Surveys can measure one or more dimensions of physical activity, assess usual physical activity habits, or provide an indication of actual physical activity undertaken within a specific time period. From a practicality and feasibility standpoint, subjective measures are seen as a favourable option for researchers for several reasons. Surveys are simple to implement, cost effective, have the potential for low researcher and participant burden, and allow for quick assessment and mass data collection (Brener, Billy, & Grady, 2003).

Survey Formats

Surveys may entail a question format, recall format, or a combination of both. Question-based surveys may include any number of questions, ranging from a single question through to multiple questions, which when combined can provide an indication of total physical activity levels. The Youth Risk Behaviour Survey (Troped et al., 2007) and the Physical Activity Questionnaire for Children (Crocker et al., 1997; Kowalski et al., 1997a) are question-based surveys, while examples of recall-based surveys include the Previous Day Physical Activity Recall (Weston, Petosa, & Pate, 1997), 3-Day Physical Activity Recall (Lee & Trost, 2006; Pate, Ross, Dowda, Trost, & Sirard, 2003), 7-Day Physical Activity Recall (Sallis, Buono, Roby, Micale, & Nelson, 1993) and the Multimedia Activity Recall for Children and Adolescents (Ridley, Olds, & Hill, 2006). Compared to stylised questions, more in-depth physical activity information can be obtained through recall formats. Such formats incorporate activity lists and time cues to assist participants to recall the activities and associated intensity of activity undertaken across a predefined period of time. Recall questionnaires have been validated for the child and adolescent population to an acceptable standard (Trost, Ward, McGraw, & Pate, 1999b; Weston et al., 1997). Building on this method, the Multimedia Activity Recall for Children and Adolescents (MARCA) uses a narrative approach where young people record all activities undertaken throughout each day from getting out of bed to eating lunch through to going to bed. This method is believed to be more consistent with the natural way in which children and young people recall past activities.

Methods of Administration

Computers, personal digital assistant (PDA), and computer tablets are common tools used to administer traditional pen and paper self-report surveys. These new delivery modes potentially reduce the participant boredom associated with traditional delivery methods. The MARCA is an example of a recently developed computer-delivered use-of-time instrument. The MARCA was recently shown to display acceptable criterion, construct, and content validity among young Australian adolescents (Ridley et al.,

2006). Because the MARCA was validated as a previous day activity recall, further validation for longer recall timeframes (e.g., 7 days) is required.

Self-Report Surveys

Several well known and frequently used instruments are presented in Table 6. The Youth Risk Behavior Survey (YRBS) consists of two questions that assess either MPA or VPA (Troped et al., 2007). The Physical Activity Questionnaire for Children (PAQ-C) consists of five questions, with each question examining physical activity participation during one of five specific time periods (i.e., during lunchtime, during recess, after-school (but before dinner), in the evening, and during the weekend) (Crocker et al., 1997; Kowalski et al., 1997a). The Physical Activity Questionnaire for Adolescents (PAQ-A) is a modified version of the PAQ-C and includes an additional question regarding physical education (Kowalski, Crocker, & Kowalski, 1997b). The Previous Day Physical Activity Recall (Weston et al., 1997), 3-Day Physical Activity Recall (Lee & Trost, 2006; Pate et al., 2003), 7-Day Physical Activity Recall (Sallis et al., 1993) and the MARCA (Ridley et al., 2006) require participants to self-report their activity behaviours over a predefined time period, retrospectively.

Table 6: Examples of Subjective Measures of Youth Physical Activity and Associated Characteristics

Measure	Recall Period	Delivery	Activities measured	Physical activity dimensions measured
Questionnaire Format				
Adolescent Physical Activity Recall Questionnaire (APARQ) (Booth, Okely, Chey, & Bauman, 2002b)	Past 7 days	Interviewer administered self-report	Organised & unorganised sport	F,D
WHO Health Behaviour for School-aged Children Survey (WHOHBS) (Booth, Okely, Chey, & Bauman, 2001)	Past 7 days	Self-report	Exercising vigorously	F,D, I
The Youth Media Campaign Longitudinal Study Survey (YMCLSS)	Past 7 days	Self-report, proxy-report	Organised & free time activity	F,
Children's Leisure Activities Study Survey (CLASS) (Telford, Salmon, Jolley, & Crawford, 2004)	Typical week	Proxy-report	Activities noted in checklist	T, F, D
Physical activity questionnaire for children (PAQ-C) (Crocker et al., 1997; Kowalski et al., 1997a)	Typical week	Self-report	Sports noted in checklist, activity during school day segments, weekend activity	F,T
Physical activity questionnaire for adolescents (PAQ-A) (Kowalski et al., 1997b)	Past 7 days	Self-report	Sports noted in checklist, activity during school day segments, weekend activity	F, T
2006 Youth Risk Behaviour Survey (YRBS) (Troped et al., 2007)	Past 7 days	Self-report	MPA; VPA	F
Self-administered physical activity checklist (SAPAC) (Ramirez-Marrero, Smith, & Sherman, 2005; Sallis et al., 1996a)	Previous day	Self-report	Physical education, recess, various activities noted in checklist	T, F, D, I, S

F, frequency; D, duration; I, intensity; T, type; S, sedentary behaviour

Table 6 Continued: Examples of Subjective Measures of Youth Physical Activity and Associated Characteristics

Measure	Recall Period	Delivery	Activities measured	Physical activity dimensions measured
Recall Diary Format				
Modifiable Activity Questionnaire for Adolescents (MAQ-A) (Aaron et al., 1995)	Past year	Self-report	Leisure-time physical activity	F, D, S
Seven-day Physical Activity Recall (7DPAR) (Sallis et al., 1993)	Past 7 days	Interviewer administered self-report	All activities	T, D, F
3-day Physical Activity Recall (3DPAR) (Lee & Trost, 2006; Pate et al., 2003)	Past 3 days	Self-report	Main activity per 30 minute block	T, F, D, I, S
3-day ACTIVITYGRAM (Treuth et al., 2003; Welk, Dziewaltowski, & Hill, 2004)	Past 3 days	Computer-assisted self-report	Main activity per 30 minute block	T, F, D, I, S
Bouchard 3-day physical activity log (Bouchard et al., 1983)	Past 3 days	Self-report	Main activity per 30 minute block	T
Previous Day Physical Activity Recall (PDPAR) (Trost et al., 1999b; Welk et al., 2004; Weston et al., 1997)	Previous day	Self-report	Main activity per 30 minute block	T, F, D, I, S
Multimedia activity recall for children and adolescents (MARCA) (Ridley et al., 2006)	Previous day	Computer-assisted self-report	All activities and behaviours	T, F, D, I, C, S

F, frequency; D, duration; I, intensity; T, type; S, sedentary behaviour

Reliability and Validity

As shown in Table 7, self-report surveys that demonstrate sufficient reliability and validity for measuring physical activity among the child and adolescent population do exist (McCormack & Giles-Corti, 2002; Sallis & Saelens, 2000; Sirard & Pate, 2001). High reliability coefficients are typically observed, indicating good stability of the measure over a predefined period of time. Using secondary measurement tools for validation purposes, low to moderate correlation coefficients are observed. This is not unexpected and is a likely product of response bias associated with subjective measures, the complexities encountered when determining the appropriate analysis of objectively-determined data, and the variation in physical activity captured by each method. Examining the psychometric properties of specific surveys, the 2005 YRBS was found to underestimate MPA and overestimate VPA when compared to accelerometer counts (Massachusetts Department of Education, 2002; Pate et al., 2002). When compared to Caltrac counts, the PAQ-C and the PAQ-A have demonstrated acceptable validity (Kowalski et al., 1997a; Kowalski et al., 1997b).

Limitations

The suitability of questionnaires to assess physical activity among the child and youth populations is low, particularly for children. Although imperfect, self-report questionnaires are a practical method for collecting data from large samples (Kohl III et al., 2000) and, if psychometrically sound, are appropriate for use with children aged 10 and above (Sirard & Pate, 2001). Proxy reports (i.e., an adult living in the same house as the child reports on the child's habitual activity levels) are used frequently to assess child activity. While this method has little correlation with more direct physical activity measurement tools (Sirard & Pate, 2001), its application may lie in collecting less rich physical activity data such as participation frequency in structured activities (e.g., sport team) but not physical activity *per se*.

Irrespective of the target population, the accuracy of self-reports to assess physical activity is hampered by their inherent subjectiveness and associated recall biases. Asking individuals to recall the type, intensity, duration, and context of activity undertaken is a difficult task, especially for

young children (< 10 years old) because of their low cognitive ability combined and the sporadic and transitory nature of their physical activity (Bailey et al., 1995; Baquet, Stratton, van Praagh, & Berthoin, 2007; Welk et al., 2000a). Accuracy of self-reported data is also influenced by social desirability (i.e., the inclination to present oneself in a manner that will be viewed favourably by others) which has resulted in the overestimation of adolescent physical activity levels (Klesges et al., 2004).

When asked to self-report, people tend to underestimate time in moderate intensity activities (e.g., incidental walking) because such activities tend to be more transient and sporadic in nature and therefore potentially more difficult to remember, and overestimate time spent in vigorous intensity activities which are likely to be structured and, as a consequence, more easily remembered (Massachusetts Department of Education, 2002; Pate et al., 2002). Thus, the focus on measuring lifestyle physical activity rather than the traditional assessment of sport and leisure-time physical activity heightens the potential for inaccurate self-reporting.

Cues are recommended to facilitate accurate recollection of memory. Physical activity checklists and using a segmented day approach (Baranowski, 1988) are memory cues which are part of several self-report instruments including the PAQ-C (Crocker et al., 1997; Kowalski et al., 1997a), the PDPAR (Trost et al., 1999b; Welk et al., 2004; Weston et al., 1997) and the MARCA (Ridley et al., 2006). Providing pictures of activities that represent different intensities (Weston et al., 1997) is also a recall aid. While shorter recall periods reduce the likelihood of recall inaccuracies, the ability to provide an accurate picture of habitual activity and determine whether an individual meets current physical activity guidelines is minimised. Repeated administration would overcome this limitation, but participant and researcher burden would be substantially increased.

Inaccuracies can also arise when self-report data are used to estimate energy expenditure (Ramirez-Marrero et al., 2005), because there is a lack of data on the energy cost of activities in children and adolescents, let alone energy costs of lifestyle activity. As energy expenditure typically decreases with age, the application of adult-based MET values to estimate energy expenditure among children is likely to be inappropriate.

Table 7: Examples of Subjective Measures of Youth Physical Activity and Associated Reliability and Validity

Measure	Participants		Reliability		Validity		Reference
	n	Age (yrs)	Test retest period	Statistic	Criterion	Statistic	
Questionnaire Format							
MAQ-A	100	15-18	1 month	r=0.79	7-day recall	r=0.55 to 0.83	(Aaron et al., 1995)
APARQ	226 2,026	13-15 13-15	2 weeks	0.25-0.74 (kappa)	Multistage fitness test	r=0.15-0.39	(Booth et al., 2002b)
WHO HBSC	226 954	13-15 13-15	2 weeks	<0.60 (kappa)	Multistage fitness test	agreement= 67- 85%	(Booth et al., 2001)
YMCLSS	192	9-13	1-week	ICC=0.60-0.78	Accelerometer counts Activity log	r=0.24 – 0.53 r=0.46	(Welk et al., 2007)
CLASS	111	10.6 (mean)			MTI/CSA counts.min ⁻¹ ,	r = 0.06	(Telford et al., 2004)
PAQ-C	43 73	9-14 11.1 (mean)	1 week	r=0.75-0.82	Caltrac counts	r = 0.39	(Crocker et al., 1997; Kowalski et al., 1997a)
PAQ-A	85	6.3 (mean)			Caltrac counts	r = 0.33	(Kowalski et al., 1997b)
2006 YRBS	125	12-13	5-40 days	r = 0.46-0.51	Count	r = 0.19 - 0.23(sensitivity, MPA) r = 0.74 - 0.92 (specificity ,MPA) r = 0.75 - 0.92 (sensitivity, VPA) r = 0.23 - 0.26 (specificity, VPA)	(Troped et al., 2007)
SAPAC	115 12	10.9 (mean) 7-9			Caltrac count Heart rate monitoring Doubly labelled water	r = 0.30 r = 0.60 r = 0.49	(Ramirez-Marrero et al., 2005; Sallis et al., 1996a)

Table 7 Continued: Examples of Key Subjective Measures of Youth Physical Activity and Associated Reliability and Validity

Measure	Participants		Reliability		Validity		Reference
	N	Age (yrs)	Test retest period	Statistic	Criterion	Statistic	
Recall Diary Format							
MAQ-A	100	15-18 yrs	1 month 1 year	r = 0.73-0.87 r = 0.48-0.71	Average of four 7-day PAR's completed 3-mths apart	r = 0.55-0.83	(Aaron et al., 1995)
7DPAR	102	5, 6, 11 th grades	Within 7-days	r = 0.77	HRM	r = 0.44-0.53	(Sallis et al., 1993)
3DPAR	105 70	13-16 14 (mean);F	6-8hrs	r = 0.79-0.92	Pedometer count CSA counts/d	r = 0.26-0.70 r = 0.46	(Lee & Trost, 2006) (Pate et al., 2003)
ACTIVITYGRAM	28 147	12.4 (mean) 12.4 (mean)			Biotrainer accelerometer Previous day physical activity recall	r = 0.33-0.50 r = 0.35-0.53	(Welk et al., 2004) (Welk et al., 2004)
Bouchard 3-day	61	10-50	6 -10 days	r = 0.91 (child only)	Sub max cycle test	r = 0.31	(Bouchard et al., 1983)
PDPAR	48 26 18 28	7-12 th grade 15-18 5 th grade 12.4 (mean)	1hr	r = 0.99-0.98	Pedometer counts Accelerometer counts ≥ 50% HRreserve Biotrainer counts	r = 0.88 r = 0.77 r = 0.63 r = 0.22-0.73	(Weston et al., 1997) (Weston et al., 1997) (Trost et al., 1999b) (Welk et al., 2004)
MARCA	32 66	11-12 11-12	Within 24 hrs	r=0.88-0.94	MTI counts	r = 0.36-0.45	(Ridley et al., 2006) (Ridley et al., 2006)

Study included both sexes unless otherwise stated; F, female

Chapter 4: Epidemiology of Youth Physical Activity

Chapter 4 provides an overview of youth physical activity levels, patterns and trends. Reasons underpinning the noted trends are explained in Chapter 5 titled 'Correlates of Physical Activity'. In particular, Chapter 4 outlines:

1. physical activity levels;
2. physical activity patterns (e.g., age, sex, time of week patterns); and
3. participation across different physical activity domains (e.g., sport).

Physical Activity Levels

National Prevalence of Active Youth

Population data on youth physical activity levels are available from several countries, including New Zealand (Table 8). Although based on subjective measurement tools, data from most countries indicate that few young people are physically active. In New Zealand, however, 68% of young people were considered physically active in 2001 (Sport and Recreation New Zealand, 2003), almost twice that of their international peers. This positive picture for New Zealand is largely an artefact of the existing national physical activity surveillance system. Compared to other countries, the definition of physically active applied to the New Zealand data was less strict and, thus, easier to achieve. When similar definitions are applied across countries, physical activity rates become more consistent. For example, when the criterion employed in the 1995/97 Health Survey for England (Prior, 1999) changed from 60 minutes to 30 minutes per day, the prevalence of physical activity among young people increased from 37.3% to 57.7%. A level closer to that reported among New Zealand children and youth.

Inconsistent methodologies employed between countries make direct comparisons of population estimates problematic. Methodological differences include the measurement tool employed, the definition of physically active, how definitions have been operationalised, and collating prevalence estimates across different age ranges. International consensus regarding the measurement of physical activity would provide greater comparability across countries. This, however, is a utopian goal because, in reality, government objectives and overall national monitoring work programmes drive the approached employed.

Table 8: Examples of National Physical Activity Surveys and Most Recent Physical Activity Levels of Youth

Country	Survey	Age (years)	Year	Percentage Active (%)			Criterion
				Female	Male	Total	
Canada	Physical Activity Monitor (Craig, Cameron, Russell, & Beaulieu, 2001)	13-17	2000	30	40		Expended 8 ⁺ kilocalories per kilogram per day (KKD)
England	Health Survey for England (Deverill et al., 2002; Prior)	2-15	2002	78	83		30 minutes per day over the past 7days
New Zealand	NZ Sport and Physical Activity Survey (Sport and Recreation New Zealand, 2003)	13-15 / 16-17	1997-01			70 / 53	2.5 ⁺ hrs of sport/active leisure in the previous 7days
	Youth 2000 Survey (Adolescent Health Research Group, 2003; Utter, Denny, Robinson, Ameratunga, & Watson, 2006)	13-17	2000	57.3	70.4	53.6	MVPA at least 3 times in the previous week VPA at least 3 times in the previous week
	NZ Child Nutrition Survey (Parnell et al., 2003)	5-14	2001	15.6	29		Children in the highest quartile physical activity group
Australia	Australian Health and Fitness Survey Pyke (1987) as in Trost (2005)	Primary/ high school students	1985	34-44	38- 50		Sustained vigorous physical activity (30 minutes at an intensity that made children “huff and puff”) 3 to 4 times a week.
Spain	National Health Survey (Lasheras, Aznar, Merino, & Lopez, 2001)	6-15	1997	36.6	28.2		Practised physical activity and sporting training several times per week
International	The Health Behaviour in School-Aged Children (Currie et al., 2004)	11 13 15	2000	33 27 22	43 41 35		60 minutes of MVPA on at least 5 days per week
United States	Youth Risk Behavior Survey (Centers for Disease Control and Prevention, 2006a)	Grades 9-12	2003	55.0	70.0	62.6	VPA for >20 minutes on >3 days per week
		Grades 9-12	2005	61.5	75.8	68.7	Participated in at least 20 minutes of vigorous activity on at least 3 days each week and/or 30 minutes of moderate intensity physical activity on at least 5 days)
		Grades 9-12	2005	27.8	43.8	35.8	At least 60 minutes/day of MVPA on >5 days per week

Tackling the issue of comparability, the Health Behaviour in School-Aged Children (HBSC) study applied the same measurement tool and methodology to assess physical activity among 11,13 and 15 year old students across both Europe and America. While a simplistic two question tool that assessed usual activity behaviour (Prochaska, Sallis, & Long, 2001) was used, this tool consistency provided the ability to make direct comparisons between countries. This study found that among 15-year-olds, 66% of boys and 78% of girls did not achieve the minimum daily activity recommendation - 60 minutes of moderate intensity physical activity on at least five days per week (Currie et al., 2004). Findings from this study clearly highlight the health issue of inactivity among young people.

Accelerometer Data

A small number of studies have used accelerometers to assess physical activity levels among youth. Using the raw count data, researchers can assess the time each participant spent in MPA and VPA, and in turn, allow adherence to current time-based physical activity guidelines to be determined. In general, accelerometer data has demonstrated similar patterns of activity (e.g., sex and age trends) to that of survey-derived data, but substantially lower prevalence estimates.

Accelerometer data collected as part of the 2003/2004 National Health and Nutrition Examination Survey in the United States showed that only 42% of children aged six to 11 years old and 8% of adolescents aged 12 to 19 years old achieved the recommended 60 minutes per day of MVPA, with even fewer adults (5%) having achieved the 30-minutes-per-day recommendation (Troiano et al., 2008). Based on a representative cohort of Norwegian youth, 86.2% of nine year olds and 55.4% of the 15 year olds met the 60-minute guideline (Klasson-Heggebo & Anderssen, 2003). Although not representative or national data, accelerometer-determined activity levels of participants in the European Youth Heart Study reported much higher adherence levels (males, 81.9%; females, 62.0%) to the 60-minute guideline (Riddoch et al., 2004).

Differing monitoring frames, subject characteristics, count data analysis, and study location may explain, in part, the large variation in the observed prevalence differential in the aforementioned studies. The reported levels are heavily dependent on the count threshold used to define movement as

moderate or vigorous (Strath, Bassett, & Swartz, 2003), of which several exist (Freedson et al., 1998; Puyau et al., 2002; Reilly et al., 2003; Trost et al., 2002a). The findings are also affected by the arbitrary decisions made in relation to data inclusion and exclusion criteria. Clarification around data cleaning and the analysis of counts is required in future articles. Similar to survey data, the inconsistent data collection and analysis methodology make cross-study comparisons difficult.

Daily Step Counts

A handful of studies have assessed youth physical activity levels objectively with pedometers (Table 9). Average daily step-count values by sex and age are commonly reported. Consistent with survey-derived findings, pedometer evidence show males are more active than females, with aggregated daily step counts ranging between approximately 10,000 and 18,000 for males, and 8,500 and 15,000 for females (Hands, Parker, Glasson, Brinkman, & Read, 2004; Le Masurier et al., 2005; Le Masurier & Corbin, 2006; Ng, 1999; Schofield, Mummery, & Schofield, 2005b; Wilde, Corbin, & Le Masurier, 2004). In addition, a trend toward reduced activity with age is typically observed (Corbin, Pangrazi, & Le Masurier, 2004; Hands et al., 2004; Le Masurier et al., 2005), with steps counts peaking at age 12.8 years for females and 14.3 years for males (Hands et al., 2004). Supporting this age trend, child-based studies tend to report higher average daily step values (Loucaides, Chedzoy, & Bennett, 2003; Rowlands & Eston, 2005; Vincent, Pangrazi, Raustorp, Tomson, & Cuddihy, 2003) than youth-based studies (Ng, ; Wilde et al., 2004)

At conception of this doctoral research in 2003, no New Zealand step data were published. In recent years, pedometer-determined physical activity levels of children and adolescence have been published, thereby, expanding current knowledge of New Zealand children's physical activity levels which, until now, was based solely on findings from proxy and self-reports. Among 91 New Zealand primary school children, step data collected over three consecutive school days equated to an average daily step count of 14,333, with typical sex differences (boys, 15,606 steps/day; girls, 13,031 steps/day) reported (Cox, Schofield, Greasley, & Kolt, 2006). A larger, more representative study of 1,115 five to 12 years old primary school students found that boys achieved higher

daily step counts than girls on both weekdays (16,133 versus 14,124) and weekend day (12,702 versus 11,158), with fewer steps achieved on weekend days for both sexes (Duncan, Schofield, & Duncan, 2007a). Likewise, a study of 1,513 girls aged five to 16 years old showed higher and less variable mean step counts on weekdays ($12,597 \pm 3,630$) than on weekend days ($9,528 \pm 4,407$), with a noticeable decline with age (Duncan, Duncan, & Schofield, 2008). Although these studies add to physical activity literature on children, objective assessment of adolescent activity is still sparse in New Zealand and internationally. Of the youth-inclusive studies that do exist, samples are typically non-nationally representative, although in some cases are drawn from large convenience samples and are homogenous, in turn, limiting the generalisability of the results.

Based on current evidence, step values are potentially biased (inflated) because studies have typically included only participants with complete step data for a predefined number of days (e.g., minimum of 4 days). While this process is not a limitation for studies on children which typically report low exclusion levels, it may potentially bias the sample and results from studies noting high exclusion levels (>30% exclusion level). High exclusion rates are apparent in studies of adolescents (Wilde et al., 2004).

Moreover, while longitudinal data are typically collected, the data collected are frequently averaged before analysis. This averaging process reduces the number of observations per participant to one and, as a consequence, reduces the statistical power. Also, when averaged, the difference in the number of usable days of data between participants is not accounted for. The common statistical analyses applied to these averages will not account for the within-subject variation or differences in variance of step counts when the number of monitoring days varies between participants. These limitations need to be addressed in future studies by the incorporation of appropriate statistical techniques (e.g., generalizing estimating equations).

Researchers have yet to examine the proportion of young people meeting currently proposed step-based guidelines (Table 2), for example, the 10,000-step threshold. This threshold, which is reflective of being considered active during adulthood (Tudor-Locke & Bassett, 2004), could be considered a conservative criterion that should be achieved by young people because of the decline of physical activity during the adolescent years.

Table 9: A Selection of Studies Examining Daily Step Counts Among the Child and Youth Populations

County	Sample size (male; female)	Monitoring frame	Age (years)	Average steps/day		Reference
				Male	Female	
Studies on children						
Sweden	356; 324	4 weekdays	6-12	15,673 -18,346	12,239 -14,825	(Vincent et al., 2003)
South-eastern Sweden	457; 435	4 days	7-14	14,911-18,346	12,238 -14,825	(Raustorp, Pangrazi, & Stahle, 2004)
Australia	278; 285	4 weekdays	6-12	13,864 -15,023	11,221-12,322	(Vincent et al., 2003)
United States	325 ; 386	4 weekdays	6-12	12,554 -13,872	10,661-11,383	(Vincent et al., 2003)
United States	112; 111	At least 4 days	Grade 7; Grade 8	12,079; 11,123	9,813; 10,620	(Le Masurier & Corbin, 2006)
Flanders, Belgium	51; 41	7 days	6.5-12.7	16,628	13,002	(Cardon & De Bourdeaudhuij, 2004)
Bangor, North Wales	15; 14	4.93 days (mean)	8 -10	16,035.4	12,729	(Rowlands & Eston, 2005)
Republic of Cyprus, Cyprus	129; 127	10 days	11-12	15,763 -17,651	11,361-13,701	(Loucaides et al., 2003)
New Zealand	45; 46	3 days	5 -10	15, 606	13,031	(Cox et al., 2006)
New Zealand	536; 579	3 weekdays & 2 weekend days	5-12	12702 - 16,133	11,158- 14,124	(Duncan, Schofield, & Duncan, 2006)
Studies including youth						
Hong Kong	65; 70	2 weekdays & 1 weekend day	12-15	9,939 - 13,414	8,857 - 11,330	(Ng, 1999)
United States	793; 1046		Grades 1-8 Grades 9-12	11,082 - 13,631 10,329 - 11,480	10,080 - 11,125 9,067 - 10,570	(Le Masurier et al., 2005)
United States	183; 184	7 days	10,12, & 14	11,283	9,472	(Strycker et al., 2007)
Arizona, US	179; 190	4 successive weekdays	Grades 9 -12	10,329 - 11,564	9,068 - 10,420	(Wilde et al., 2004)
Western Australia	1,142; 1,133	7 successive days	Primary school age High school age	12,602 14,167	10,864 11,925	(Hands et al., 2004)

Physical Activity Patterns

Age Trends

Adolescence is a period of life typically associated with reduced physical activity (Brodersen, Steptoe, Boniface, & Wardle, 2007; Caspersen, Pereira, & Curran, 2000; Duncan, Duncan, Strycker, & Chaumeton, 2007b; Pate, Dowda, O'Neill, & Ward, 2007; Riddoch et al., 2004; Seabra et al., 2008; Troiano et al., 2008; Van Mechelen et al., 2000; Zick, Smith, Brown, Fan, & Kowlaeski-Jones, 2007). A review of early literature reported an annual decline of 2.7% for males and 7.4% for females during the school years (Sallis, 1993). More recently, between the ages of nine and 19, prospective data from self-report diaries revealed a 35% absolute reduction in physical activity among females, whilst accelerometer data indicated an annual decline in the range of 10% to 13% (Kimm et al., 2002; Kimm et al., 2000). This age-related decline is observed in both males and females (Klasson-Heggebo & Anderssen, 2003; McMurray, Harrell, Bangdiwala, & Hu, 2003; Sallis, 2000; Telama & Yang, 2000; Van Mechelen et al., 2000) and is particularly apparent for vigorous, rather than moderate, intensity activities (Van Mechelen et al., 2000). Using a longitudinal cohort study design, the Dunedin Multidisciplinary Health and Development Study revealed that girls spent significantly fewer hours being physically active at age 18 relative to levels at age 15 (7.5 versus 4.3 hours per week, respectively). A similar trend was noticed among males also (11.7 versus 7.8 hours per week, respectively). Total time spent in physical activity at age 18 equated to 63% of the total time reported at age 15 (Dovey, Reeder, & Chalmers, 1998).

Sex

Data obtained from pedometers (Le Masurier et al., 2005; Le Masurier & Corbin, 2006; Vincent et al., 2003; Wilde et al., 2004), accelerometers (Jago, Baranowski, Zakeri, & Harris, 2005b; Janz et al., 2005; Klasson-Heggebo & Anderssen, 2003; Pate et al., 2002; Riddoch et al., 2004; Sanchez et al., 2007; Trost et al., 2000; Trost et al., 2002a; Tudor-Locke, Ainsworth, Adair, & Popkin, 2003c), and surveys (Adolescent Health Research Group, 2003; Caspersen et al., 2000; Dovey et al., 1998; Gordon-Larsen, McMurray, & Popkin, 1999; Li, Dibley, Sibbritt, Zhou, & Yan, 2007; Seabra et al., 2008; Tammelin, Ekelund, Remes, & Näyhä, 2007; Telama & Yang, 2000) consistently show males to be

more active than their females counterparts. This trend is true for total physical activity, MPA, and VPA, with latter associated with larger disparities by sex. Consequently, meeting physical activity guidelines is more prominent among males than females (Li et al., 2007; Sanchez et al., 2007; Troiano et al., 2008).

Ethnicity

Despite the disproportionate level of inactivity-related health issues between ethnic groups (Delva, O'Malley, & Johnston, 2006), there is a dearth of published research investigating physical activity patterns by ethnicity (Sulemana, Smolensky, & Lai, 2006). When examined, the ethnic background of an individual is typically determined by applying prioritisation procedures or by asking participants to state the ethnic group to which they most strongly identify. In countries like New Zealand where inter-racial families are common, categorising individuals into one homogenous ethnic group and conducting ethnic analyses becomes problematic. Hence, the complexities associated with ethnicity are dealt with in a simplistic manner by confining individuals to one ethnic group for the purpose of analyses. Moving forward, ethnic analyses should take into consideration the heterogeneity of an individual's ethnicity, especially in countries like New Zealand where inter-racial relationships are common.

Because of New Zealand's ethnically diverse population combined with the Te Tiriti O Waitangi (Treaty of Waitangi), understanding ethnic-related correlates and those specific to Māori (tangatawhenua, indigenous people of the land) is pertinent. The largest ethnic group in New Zealand is European (67.6%), followed by Māori (14.6%), New Zealanders (11.1%), Asian (9.2%), Pacific people (6.9%), and individuals of Middle Eastern, Latin American, and African descent (0.9%) (Statistics New Zealand, 2006).

Findings regarding the ethnic-physical activity link are mixed. In the United States, compared to nonminority peers, minority racial/ethnic groups have displayed lower physical activity levels (Booth, Okely, Chey, Bauman, & Macaskill, 2002a; Felton et al., 2002; Gordon-Larsen et al., 1999; Grunbaum et al., 2002; Sallis, Prochaska, & Taylor, 2000) and frequency of exercising vigorously (Delva et al., 2006). In New South Wales, Australia, high school students of Asian or Middle-Eastern backgrounds were found less likely to be active compared to students of European or English-speaking background

(Booth et al., 2002a). Data from the New Zealand Sport and Physical Activity Survey (NZSPAS) showed that 71% of Māori aged five to 17 years old engaged in 2.5 hours of sport and active leisure per week; a level similar to that of their European peers (70%), but higher than other ethnic minority groups (Pacific, 52%; Other, 59%) (Sport and Recreation New Zealand, 2003). Based on self-report rather than proxy reports used in the NZSPAS, the Youth2000 survey revealed a similar ethnic trend for vigorous intensity physical activity (VPA). In particular, significantly more Māori (71%) and European (70%) high school students achieved at least three sessions of VPA per week compared to Pacific people, Asians, and those from the 'Other' ethnic category. The lowest rate of VPA was noted among the Asian group (Utter et al., 2006).

Socioeconomic Status

Low social class is a key indicator associated with unhealthy behaviours (Brodersen et al., 2007; Delva et al., 2006; Janssen, Boyce, Simpson, & Pickett, 2006; Kantomaa, Tammelin, Nayha, & Taanila, 2007; Popham & Mitchell, 2007) and poor health outcomes (Delva et al., 2006; Ministry of Health & University of Otago, 2006; Muennig, Sohle, & Mahato, 2007; Wardle, Brodersen, Cole, Jarvis, & Boniface, 2006; Xie, Chou, Spruijt-Metz, & Reynolds, 2007). While socioeconomic status is often controlled for in physical activity studies, it is rarely examined as the primary variable of interest.

Numerous indicators of socioeconomic status exist. Parental employment, parental education, and household income are frequently surrogate indicators used to assess socioeconomic status. Composite measurement tools also exist. For example, The Family Influence Scale is a validated measure of material affluence of a child's household which is based on car ownership, number of household bedrooms, telephone ownership and frequency of family holidays. Composite measures, however, do not elucidate which specific socioeconomic factors are most strongly associated with physical activity or specific physical activity domains. Indicators can also be grouped as individual- (i.e., car ownership), or area- (i.e., unemployment rate in a specific neighbourhood) level. Early research was limited by obtaining socioeconomic status information directly from adolescents who are generally not aware of their parent's level of income, type of occupation, or education level (Currie, Elton, Todd, & Platt, 1997), rendering the collected information erroneous. Obtaining

socioeconomic-related data directly from parents strengthens the reported findings.

Like ethnicity, mixed findings have been reported regarding the link between socioeconomic status and physical activity participation. Reviewing six studies, Sallis, Prochaska, and Taylor (2000) concluded that socioeconomic status was not associated with adolescent physical activity. Recent research, however, has demonstrated that a positive association to be the rule rather than the exception despite different socioeconomic status indicators and physical activity tools being employed (Kantomaa et al., 2007; McMurray et al., 2000; Statistics Canada, 2000; Utter et al., 2006).

Using The Family Influence Scale to assess socioeconomic status, Scottish children of low socioeconomic position reported lower levels of VPA, especially females (Inchley et al., 2005). Among New Zealand high school students, frequency of VPA was higher among those of higher socioeconomic position. This was found true for various indicators including parent employment level, number of parents, school decile, car availability, and household phone availability (Utter et al., 2006). Low family income was associated with substantially lower participation rate in sport among Canadian children aged five to 14 years old (Statistics Canada, 2000). Among Spanish children aged six to 15 year olds, national data revealed a positive association between the social status of the head of the child's household and the child's total physical activity level (Lasheras et al., 2001). Similarly, Raudsepp (2006) found parental occupational title, but not economic status, was correlated with self-reported physical activity levels among adolescents aged 12 to 15 years old. The authors attributed the failed association with economic status with the socioeconomic situation of Estonia at the time of this study, at which time social status was not necessarily reflective of economic status. For example, a university specialist could rank in the lower- to-medium income levels. Among Canadian youth aged 11 to 15 years old, individual-level (i.e., low material wealth and perception of low family wealth), but not at the area-level (i.e., unemployment rate, education level, employment income in area surrounding each participant's school) indicators of socioeconomic position were associated with an increased likelihood of not achieving the 60 minutes of MVPA per day recommendation (Janssen et al., 2006). These findings suggest that modifying individual and

family level socioeconomic indicators may influence physical activity levels among youth.

In addition to overall physical activity, socioeconomic status affects participation in domain-specific activities. Socioeconomic status has been inversely associated with participation in physical education classes and out of school activity lessons (Sallis et al., 1996b). Similarly, low parental education and occupation were associated with lower participation levels in extracurricular activities (La Torre et al., 2006) and organised activities (Santos et al., 2004). Using an index (i.e., Australian Bureau of Statistics Economic Index of Relative Disadvantaged Areas) to categorise children (aged 9 to 13 years) into mutually exclusive socioeconomic status groups, Salmon, Timperio, Cleland, Venn (2005) reported that in 1985 and 2001 low socioeconomic positioned children participated in fewer sessions of physical education and sport per week. This outcome is a likely by-product of high socioeconomic schools having access to more resources. In terms of active transportation, children in the low socioeconomic status group walked less frequently to school compared to children in the high socioeconomic status group in 1985, with this trend reversed in 2001.

It is likely that various indicators of socioeconomic status will exert an influence on specific physical activity domains. For instance, financial income may exert a greater influence on sport participation than active transportation, because greater financial resources are required. In contrast, car availability may be more influential socioeconomic status indicator of active transportation. More research is required to elucidate the impact that specific indicators socioeconomic status have on various domain-specific activities.

Obesity

Compared to their lighter peers, obese people expend more energy when performing at a given level of physical activity. However, obese people tend to do fewer energy demanding activities. Both cross-sectional and longitudinal prospective studies have consistently shown that leaner children and adolescents display higher physical activity levels and lower levels of sedentary behaviours than their overweight counterparts.

Several studies have examined the obesity-physical activity link using cross-sectional data (De Bourdeaudhuij et al., 2005; Ekelund et al., 2004;

Janssen, Katzmarzyk, Boyce, King, & Pickett, 2004; Patrick et al., 2004; Tremblay & Williams, 2003; Vaughan, Kilkkinen, Heistraro, Laatikainen, & Dunbar, 2007) . European children aged nine to 10 years old who accumulated less than one hour of accelerometer-determined MPA per day were significantly fatter than those who accumulated greater than two hours per day (Ekelund et al., 2004). Among Hispanic young people aged four to 19 years old, overweight individuals achieved significantly lower total daily activity counts and higher sedentary activity counts compared to their nonoverweight peers (Butte, Puyau, Adolph, Vohra, & Zakeri, 2007). Based on a small convenience sample of girls aged 14 to 17 years old, Sulemana, Smolensky, and Lai (2006) reported that normal-weight females achieved a 10% higher diurnal activity level compared to overweight females, and 6% higher activity level compared to females at risk of being overweight.

Longitudinal studies provide stronger evidence of the obesity-physical activity connection (Berkey et al., 2000; Boone, Gordon-Larsen, Adair, & Popkin, 2007; Menschik, Ahmed, Alexander, & Blum, 2008; Moore, Nguyen, Rothman, Cupples, & Ellison, 1995; Salbe et al., 2002; Stevens et al., 2007; Tammelin et al., 2004). Data from the Framington Children Study showed inactive preschoolers (as assessed by Caltrac accelerometer) gained substantially greater subcutaneous adiposity than their more active peers as they moved through to first grade (Moore et al., 1995). As young people move into adulthood, research shows that students who participated in daily physical education in 8th Grade through to 12th Grade or participated in regular extracurricular activities (i.e., > four times per week) had reduced odds of becoming overweight during early adulthood by 28% (Menschik et al., 2008). Another study conducted over a 21-year period reported that adolescents who displayed decreasing activity levels or were found to be persistently inactive during adolescence were more likely to be obese as adults when compared with persistently active peers (Yang, Telama, Viikari, & Raitakari, 2006).

The magnitude of the obesity-physical activity relationship is typically weak and the variance explained is low (Butte et al., 2007; Ekelund et al., 2004). These findings are not unexpected as obesity is influenced by a multitude of factors, physical activity being only one of its modifiable factors. The common use of, and recall bias associated with, self-report tools likely attenuate the observed relationship. In particular, obese individuals tend to

provide socially desirable responses, in that they over-report physical activity and under-report dietary intake (Buchowski, Townsend, Chen, Acra, & Sun, 1999; Samaras, Kelly, & Campbell, 1999; Stice, Shaw, & Marti, 2006; Zalilah, Khor, Mirnalini, Norimah, & Ang, 2006). To obtain strong evidence of the obesity-physical activity link, persistence of physical activity should become the standard measure, with data on physical activity collected with objective rather than with subjective tools.

Collectively, the abovementioned findings suggest that changes in physical activity patterns during the human lifecycle may contribute to the development of future obesity. This is particularly so if persistent inactivity or decreasing activity levels are noted during adolescence.

Day of Week

In addition to determining overall physical activity levels, identifying key periods of low physical activity will help direct future health promotion attention and efforts. A convenient way to delineate these periods for youth is by dividing the week into school days and weekend days.

For adolescents, evidence tends to support reduced activity on weekend days. Reduced activity levels on weekend days have been shown among a sample of Norwegian nine and 15 year olds based on four days of accelerometer data (Klasson-Heggebo & Anderssen, 2003) and also among children and adolescents in the United States based on pedometer data (Rowe et al., 2004; Strycker et al., 2007). In contrast, analysing heart rate data collected over a seven-day period, no difference in activity level by type of day was found among a sample of primary and secondary school students (Gavarry, Giacomoni, Bernard, Seymat, & Falgairette, 2003).

Some studies show this trend differs by age group. Using accelerometers, a United States-based study reported reduced MVPA levels on weekend days compared to weekdays for adolescents, while the opposite was reported for children (Troost et al., 2000). In Western Australia, high school students accumulated more steps on weekend days than weekdays whilst the opposite trend was observed for primary school children (Hands et al., 2004). Although the findings were based on a representative sample of Western Australian school student, the significance level was not reported. Proxy report data from parents in New Zealand revealed a larger proportion of children aged

11 to 14 years old did no active behaviour on weekends compared to their younger peers (Parnell et al., 2003), however, the level of significance was not reported.

Collectively, the paucity of research, inconsistent methodologies, and differing sample characteristics between studies has likely contributed to the equivocal findings noted. Further investigation of type of day differences is warranted, with ethnic and socioeconomic differences needing consideration.

Time Trends

A decline in physical activity among youth during the last few decades is often purported, but not always supported by national data. Data from the Youth Risk Behaviour Survey (YRBS) indicated that no substantial change in VPA or MPA participation rates for high school students in the United States between 1991 and 2005 (Centers for Disease Control and Prevention, 2006b). Canadian data showed that the proportion of youth achieving the recommended activity energy expenditure of 12.6kJ/kg/day actually increased between 1981 and 1988 and then stabilised through to 1998 (Eisenmann, Katzmarzyk, & Tremblay, 2004a). In New Zealand, the national Sport and Physical Activity Surveys indicated little change in the number of people partaking in at least one sport or active leisure activity (Sport and Recreation New Zealand, 2003). The finding is limited by the short monitoring period of four years (1997 to 2001) and a highly achievable criterion.

Based on national data, it appears that physical activity levels have not declined but remained stable (or in some instances increased). The ability to collect strong evidence of youth physical activity time trend data is substantially hindered by the limitations of current survey methodology typically employed in national surveillance systems. The incorporation of objective assessment tools will enhance the accuracy of monitoring national physical activity levels and time trends. Even though it appears that physical activity levels have not changed over time, the proportion of people engaging in different contexts may have. Aside from assessing overall physical activity, examining specific contexts in which activity takes place may provide greater insight regarding physical activity trends. Participation in context (i.e., sport participation, physical education activity, active transportation) and time-specific (i.e., recess, after-school activity) physical activities will now be presented.

Domain and Time Specific Physical Activity Levels

Importance of Domain and Time-Specific Physical Activities

Each day, whether during the school week or on the weekend, children and youth are faced with numerous opportunities to accumulate part of their recommended daily dose of physical activity. On a school day, key time periods include before school, during recess, during lunchtime, and the after-school period. Key physical activity domains undertaken by youth include, sport, physical education, and active travel. Substantial evidence exists that supports the importance of each time- and domain-specific activity.

Over a school year students get exposed to numerous recess breaks, with the main recess periods typically occurring once during the morning and at lunchtime. For certain groups (e.g., sedentary youth, ethnic groups), recess may be the only regular and consistent physical activity opportunity they have. While the contribution of recess physical activity to overall daily activity levels has yet to be examined among high school students, evidence for the child population does exist. Using objective measures, school children in England were found to accumulate over one-third of the recommended hour of MVPA during recess and lunchtime, (Ridgers & Stratton, 2005; Ridgers, Stratton, & Fairclough, 2005). Among a small sample of sixth grade students in the United States, lunchtime-related physical activity accounted for approximately 15% of participants daily MVPA level (Tudor-Locke, Lee, Morgan, Beighle, & Pangrazi, 2006). A 15% increase in recess-related MVPA translated into children accruing an additional nine minutes of MVPA per day (Zask, van Beurden, Barnett, Brooks, & Dietrich, 2001); an achievable level of increase considering children typically spend less than 50% of recess engaged in MVPA (McKenzie et al., 1997; Ridgers et al., 2005).

Physical education (PE) is a mandatory class during the first two years of high school in New Zealand. Engagement in PE has a positive influence on daily activity levels of both children (Dale, Corbin, & Dale, 2000; Henry, Webster-Gandy, & Elia, 1999) and adolescents (Gordon-Larsen et al., 2000) positively. Physical education students have been found to accumulate approximately 2,000 more steps daily than students who did not participate in either PE or sport (Wilde et al., 2004). Another study of 12,000 participants involved in the National Longitudinal Study of Adolescent Health reported that, compared to students classified as the high television viewing group, students

with high in-school activities (i.e., sport, academic clubs, PE) were at least twice as likely to meet adult physical activity guidelines seven years later and over four times as likely to meet physical activity guidelines during adolescence (Nelson, Gordon-Larsen, Adair, & Popkin, 2005). In addition to providing a physical activity opportunity, PE provides other beneficial effects including increasing reduced odds of being overweight as an adult with each weekday that adolescents participated in PE. Similarly, adolescents who participated daily in PE were 28% more likely to be normal-weight adults than non-PE peers (Menschik et al., 2008).

The after-school period, defined as the time between the end of a school day and dinner time, is considered a 'critical window' for young people to accumulate necessary health-related physical activity. Among New Zealand primary school children, active and nonactive children achieved similar step counts during school hours but active children accumulated more steps after school. The authors concluded that the observed differences are a likely result of the increased time and potentially greater range of activities available to outside of the school environment (Cox et al., 2006). Likewise, sixth grade children in the United States were found to accumulate almost half of their daily steps during after-school activities (Tudor-Locke et al., 2006). Although a discrepancy between out-of-school and in-school physical activity levels appears to exist, whether children are maximising the in-school hours to be active was not determined nor was the domain activities (e.g., organised sport, PE class) potentially underpinning these time-of-day disparities. Because the studies did not determine if students are maximising all opportunities during school hours to be active, the aforementioned findings do not undermine the potential of targeting in-school physical activity.

Actively commuting to and from school is recommended for all young people (Department of Health, 2004; US Department of Health and Human Services, 2000). It contributes to a reduction in air and noise pollution and provides an opportunity for young people to be habitually active and accumulate part of their daily physical activity dose on a regular basis.

Among children, active travel has been associated with a more active profile (Cooper, Andersen, Wedderkopp, Page, & Froberg, 2005; Gordon-Larsen, Nelson, & Beam, 2005; Sirard, Riner, McIver, & Pate, 2005) and higher fitness level (Cooper et al., 2006). Accelerometer-determined activity levels of

13 and 14 year olds in Edinburgh showed that students who walked to and from school achieved 123.1 minutes of MVPA daily, 25.9 more minutes than their peers who travelled by car, bus, or train (Alexander et al., 2005). Similarly, data from over 1,700 sixth grade females participating in the Trial for Activity for Adolescent Girls showed that girls who walked to and from school achieved an average of 13.7 more minutes of total physical activity and 4.7 more minutes of MVPA than nonwalkers (Saksvig et al., 2007). Among US children in Grades four to 12, students who typically walked or biked to school were 1.8 times more likely to achieve at least five days that included MPA, although no differences were noted in terms of VPA (Fulton, Shisler, Yore, & Caspersen, 2005).

Walking, a potentially health promoting behaviour, is often undertaken at a light intensity thereby reducing its relative impact on daily energy expenditure and obtaining intensity-related health benefits. Among Australian 11 to 12 year old children, active travel only accounted for 1.3% of daily energy expenditure (Harten & Olds, 2004); a figure potentially underestimated because it was based on survey-derived data. Although the contribution of individual bouts of active travel to daily activity levels and energy expenditure is potentially small, its impact lies in the potential for it to become a habitual, daily activity. A study of 14 to 16 year old Filipino youth found that active commuting contributed over 30 kcal.day⁻¹ (males: 44.2 kcal.day⁻¹; females: 33.2 kcal.day⁻¹) to daily energy expenditure. Based on a 200-day school year, habitual expenditure of this magnitude equated to a yearly energy expenditure of 8,840 kcal and 6,640 kcal for males and females, respectively. This energy difference potentially reflects a 1.5kg weight gain for motorised transit users (Tudor-Locke, Ainsworth, Adair, & Popkin, 2003b). If undertaken habitually, active travel can make a considerable contribution to energy expenditure over time.

Another key physical activity domain for youth is sport. Like another physical activity domains, sport participation during adolescence has numerous benefits including the accumulation of greater daily step counts (Wilde et al., 2004 7039) and increased likelihood of engaging in physical activity (Tammelin, Nayha, Hills, & Jarvelin, 2003) and sport (Vanreusel et al., 1997) during adulthood. According to data from the Dunedin Multidisciplinary Health and Development Study, individuals who played school sport at age 15 were 1.8 times more likely to spend more than four hours per week in physical activity at age 18 (Dovey et al., 1998). Accelerometer data from boys aged six and 12

years old indicated that approximately 23% of the total daily time spent in MVPA was attributable to sport participation, while PE and recess contributed almost 11% and 16%, respectively. Also, significantly more sedentary activity and significantly less MVPA took place on a nonsport day compared to levels noted on a sport day (Wickel & Eisenmann, 2007). Considering 52% of sport time was spent by the boys in either sedentary or light-intensity state, there is room for sport to provide an even greater contribution to daily physical activity levels. Sport participation confers several other benefits including reduced risk of obesity (Elkins, Cohen, Koralewicz, & Taylor, 2004), suicidal behaviour (Ferron, Narring, Cauderay, & Michaud, 2003; Sabo, Miller, Melnick, Farrell, & Barnes, 2005), being a smoker (Ferron et al., 2003; Rodriguez & Audrain-McGovern, 2004), engaging in sexual behaviour (females) or falling pregnant (Sabo, Miller, Farrell, Melnick, & Barnes, 1999) and substance use (Ferron et al., 2003), with the latter depending on the sport played (Moore & Werch, 2005).

In light of the beneficial affect each time period or domain-specific activity makes to daily activity levels, epidemiological data pertaining to each time-dependant opportunity will now be discussed.

Sport

National data suggests that sport is a common activity among young people in many countries, including New Zealand. In general, at least 50% of young people per country have participated in some sport yearly with differences noted between sexes and across age groups (Table 10).

Compared to females, males typically participate in sport more frequently (Eaton et al., 2006; Richards, Reeder, & Darling, 2004; Statistics Canada, 2000) and are more likely to be a member of a sports club (Vilhjalmsson & Kristjansdottir, 2003). New Zealand national data however failed to show a large sex difference. This result is likely obscured by the use of a lenient definition (i.e., participated in one activity over a 12-month period) and not analysing sport and active leisure separately. Although not national data, a large cohort study of New Zealand Year 10 and 12 students showed males to be 15% more likely to participate in sport (Richards et al., 2004).

With regards to age, young people tend to partake in more sport/active leisure (Sport and Recreation New Zealand, 2003), extra-curricular sport activities (Sports Council for Wales, 2003a, 2003b), regular sport participation

(Stubbe, Boomsma, & De Geus, 2005) than their older adolescent peers. These age disparities are more pronounced for females (Eaton et al., 2006). Data from the American Time Trend Survey showed that between ages 15 and 29, a decline in the proportion of people accumulating at least 30 minutes of sport (Zick et al., 2007) occurred. A study of Portugal youth aged 12 to 20 years old, participation in nonguided, unstructured sport activities (but not guided structured sport activities) was found to decrease with age (Mota & Esculcas, 2002). The aforementioned findings, however, are based on cross-sectional analyses thereby providing relative (and not absolute) age differences.

Differences in sport participation by ethnicity are evident. New Zealand data indicate that more young people who identify as Māori or New Zealand European/Other participated in sport/leisure activities compared to Pacific people (Sport and Recreation New Zealand, 2003). Similarly in the United States, more White (57.8%) than African-American (53.7%) and Hispanic (53.0%) students reported participating in at least one sports team during the year preceding the 2005 Youth Risk Behavior Survey (Eaton et al., 2006).

Time trends in sport participation vary widely across countries, with findings dependent on the sport-specific context and age group examined. In Wales, participation rates in club-based activities among adolescents increased from 67% to 73% between 1999 and 2001, yet over the same time period no change in extracurricular activities participation occurred (Sports Council for Wales, 2003b). Between 1991 and 2005, no change in participation levels in at least one sport team over a 12-month period was noted among United State high school students (Centers for Disease Control and Prevention, 2006b). Using a more stringent criteria, regular sport participation levels declined by 8.6% between 1992 (76.8%) and 1998 (68.2%) among Canadians aged 15 to 18 years old (Statistics Canada, 2000). Similarly, organised sport declined by approximately 1.5% per annum among Australian youth aged nine to 15 years old over the last 20 years (Dollman et al., 2005).

Table 10: Selection of Population Studies and Respective Findings of Youth Sport Participation Levels

Country	Survey	Age (year)	Participation levels (%)			Definition
			Male	Female	Total	
USA	2005 Youth Risk Behavior Surveillance System (Eaton et al., 2006)	Grades 9-12	57 - 65	41 - 56	49 - 60	Participated in one or more sport teams during the 12 months preceding the survey
Canada	1998 General Social Survey (Statistics Canada, 2000)	15-18			68.0	Regular (> once a week/season) participation in organised sport
Canada	General Social Survey (Statistics Canada, 2000)	5-14	61	48	54	Participated in some form of sport yearly
England	Young People and Sport National Survey (1994, 1998 & 2002) (Sport England, 2003)	6-16			98	Engaged in some sort of out-of-class sporting activity
Australia	2003 Survey of Children's Participation in Cultural and Leisure Activities (Australian Bureau of Statistics, 2003, 2006)	5-14	69	54	62	Participated in organised sport outside of school hours during the previous 12 months
New Zealand	2005 New Zealand Secondary Schools Sports Council Annual Report 2005 (New Zealand Secondary Schools Sports Council, 2005)	9-12	56	51	54	Represented their high school in sport in 2005
New Zealand	Sport and Physical Activity Surveys (combined data 1997, 1999 & 2001) (Sport and Recreation New Zealand, 2003)	13-15 16-17	93	91	94 79	Participated in at least one sport/active leisure activity over a two-week period
Wales	2001 Secondary School Aged Children's Participation in Sports Survey (Sports Council for Wales, 2003b)	11-16 11-16 11-16	76 59	69 44	72 43	Participated in an extracurricular activity in the last year Participated in an extracurricular activity at least once a week Participated in club-based sports

Because of inconsistent definitions of sport participation, direct comparison of participation rates between countries and studies is not possible. These inconsistencies are reflected in the diversity of findings noted. For most countries, the available statistical data on sport does not consider regularity of participation, an important aspect for participation to confer health benefits. When the regularity of participation is considered, participation levels decrease substantially. For example, in Wales participation levels in extracurricular activities (organised sport at lunchtime, after school, and on the weekend by school) and club-based activities decreased among teenagers aged 11 to 16 years old when the criterion changed from once during the past year (72% and 73%, respectively) to at least once a week (43% and 53%, respectively) (Sports Council for Wales, 2003b). While some countries have a comprehensive monitor of youth sport, this is notably lacking in New Zealand.

Physical Education

It has been recommended that students should engage in MVPA for at least 50% of physical education (PE) class time (US Department of Health and Human Services, 2000). Most middle and high school PE classes in the United States fall short of reaching this target (Fairclough & Stratton, 2005a). Nevertheless, both self-report (Grunbaum et al., 2004) and accelerometer (Fairclough & Stratton, 2005b) data indicated that students can still accumulate approximately 20 minutes of health promoting physical activity during scheduled PE classes.

Most data relating to PE have been collected in the United States, in turn, reducing the generalisability of the following findings to other countries. According to the 2005 Youth Risk Behaviour Survey, few high school students attended PE class daily (33%) or weekly (54.2%), attendance was higher among males than females in terms of both daily (44.8% and 22.4%, respectively) and weekly (71.5% and 38.8%, respectively) attendance, and that attendance levels decreased with age (Eaton et al., 2006). Between 1985 and 2001 in Australia, a decline in the frequency of PE class for children was reported (Salmon et al., 2005). PE data has also been collected from Western Australian primary and secondary school students, but data pertaining to school sport and PE were not analysed separately (Hands et al., 2004). In New Zealand, 10% of children aged between 11 and 14 years old reported having no

PE class (Parnell et al., 2003). In countries like Canada and New Zealand, enrolment levels tend to deteriorate post the mandatory years (e.g., Years 9 and 10) where PE is a compulsory subject (Spence, Mandigo, Poon, & Mummery, 2001). Consequently, the more active students are more likely to enrol in PE as an elective, reducing the potential impact PE may have on students who most require it the most - the sedentary.

Physical education has been part of the school curriculum for many years, yet descriptive data about high school PE across multiple countries are sparse. To date, the Youth Risk Behavior Survey provides the most comprehensive data publicly available. More research should be conducted from both an epidemiological perspective and pedagogy perspective to determine the effectiveness of PE on youth physical activity levels.

School Recess

Both nationally and internationally, only a small body of research has focused on young people's engagement in physical activity during school breaks, with greater scarcity of evidence for the adolescent population. In New Zealand, results from the Children's Nutrition Survey indicated that among 5 to 14 year olds, more boys than girls were active (i.e., they ran around and played quite a bit or played hard most of the time) during morning recess (76% and 61.6%, respectively) and lunchtime (85.2% and 71.5%, respectively) breaks. Also, older females (46.5%) and older males (71.9%) were less likely to report being active during lunchtime than their younger counterparts (86.6% and 93%, respectively) aged seven to 10 years (Parnell et al., 2003). Similarly, among a representative sample of both primary and secondary school students in Western Australia, approximately 70% of primary school students reported 'running around, playing quite a bit, or playing quite hard' during recess and lunchtime compared to approximately 6% of high school students who typically (approximately 85% of students) sat down, stood, or walked around during these school-day breaks (Hands et al., 2004).

After-School Activity

This period of the day has received little attention among epidemiological studies, especially for the high school population. Available evidence shows that

involvement in activity after school declines with age (Schofield, Mummery, Schofield, & Walmsely, 2002), physical activity outside of school is almost nonexistent among Chinese school children aged six to 18 years old (Tudor-Locke, Ainsworth, Adair, Du, & Popkin, 2003a), and that among adolescents in the United States, accelerometer data indicate that, compared to females, males were less sedentary and participated in more MPA during the late afternoon time period (Jago et al., 2005b), while females have been shown to be more active during school periods than after school (Mota, Santos, Guerra, Ribeiro, & Duarte, 2003).

Lack of data and the potential importance of the after-school period as a time for activity support the need for further examination of physical activity during this school day segment.

Active Travel To and From School

In contrast to past generations, walking or cycling to school is the exception rather than the rule among today's youth (Table 11). In 1969, 42% of all students walked or cycled to school in the United States (US Department of Transportation, 1972). In 2004, only 17% of school goers in the United States regularly walked to or from school at least once a week (Martin & Carlson, 2005). In westernised countries, the availability of, and access to, cars has partly contributed to the diminishing levels of active travel and passive transit modes becoming more prevalent. In 2000, 51% of Canadian young people were passive transit users while only 25% used active transportation, with walking less frequent among secondary school students compared to their primary school peers (Craig et al., 2001). The following nonrepresentative, non-national studies also support a low active travel levels. Among a sample of high school students in Queensland, Australia, 10% were found to engage in active travel between the hours of 3.00pm and 7.30pm (Schofield, Schofield, & Mummery, 2005a). Among Filipino students, 40% reported walking to school as typical behaviour with a similar proportion employing a combination of modes (e.g., walked/motorised transport), but only 1% cycled (Tudor-Locke et al., 2003c). In contrast and according to the China Health and Nutrition Survey data, 84% of Chinese youth travel actively commuted to school with a median commuting time of 100-150 minutes per week (Tudor-Locke et al., 2003a).

Table 11: Active Transportation Levels from a Sample of Population Studies

Country	Survey	Year	Age (yrs)	% of total trips	Participation levels (%)	Definition
Canada	Physical Activity Monitor (Craig et al., 2001)	2000	5-12; 13-17		32; 25	Use only active transportation modes to/from school
			5-12; 13-17		54.0; 48.0	Use only passive transit to and from school
China	China Health and Nutrition Survey (Tudor-Locke et al., 2003a)	1997	6-18		84.0	Reported actively commuting to school
Great Britain	National Travel Survey (Department for Transport, 2004)	1991/93; 2001	11-16		46.0; 38.0	School trips walked
					4.0; 2.0	School trips cycled
					15.0; 24.0	School trips by car
New Zealand	Children's Nutrition Survey (Parnell et al., 2003)		5-14		37.2	Walked/biked to school \geq 6 trips per week
					46.9	Never commuted actively to school
Switzerland	Travel Behaviour Microcensus (Martin-Diene & Sauter, 2005)	2000	13-15; 16-17		30.9; 18.7 27.6; 20.0	Trips to and from school walked Trips to and from school cycled
USA	Nationwide Personal Transportation Survey (US Department of Transportation, 1972)	1969	5-18		42.0	Walked or cycled to school
					87.0	Walked/cycled to school and lived within 1-mile of their school
					16.0	Driven/drove to school
	National Transportation Personal Survey (Sturm, 2005)	1977; 1999	5-15		20.2; 16.6	School trips walked
	National-level survey (Fulton et al., 2005)	1996			14.0	Typically walk or bike to and from school
	National Household Travel Survey (Sturm, 2005)	2001	5-15		12.5	School trips walked
	Consumer Styles Survey (Martin & Carlson, 2005)	2004	5-18		17.0	Walk to or from school at \geq once a week

Total trips attributable to active transportation modes have also declined. While such analyses preclude the ability to identify the proportion of students commuting actively, a reduction in walking and cycling trips is noticeable. In the United States, a 40% decline in school trips attributable to walking occurred between 1977 and 2001. For adolescents in particular, a 50% (1977, 20.9%; 2001, 10.9%) reduction was reported (Sturm, 2005). Over a 10-year period (1991/93 to 2002), walking trips of school students' in Great Britain decreased by 8%, cycling trips halved, while car use increased by 9% (Department for Transport, 2004). In Switzerland, the proportion of actively commuted trips to and from school remained relatively stable between 1994 and 2000, but less than one-third of modal trips by high school students were walked or cycled. Also, an upward trend for car use across all age groups was noted (Martin-Diene & Sauter, 2005). Distance to school has increased over time and may account for half of the noted decline in active transportation to school (McDonald, 2007).

New Zealand evidence of active commuting is limited. According to the National Travel Survey data, the number of car-related trips to and from school for primary school children almost doubled between 1989/90 and 1997/98, with little change in either walking or bicycling trips. Being driven to school was the most common mode of transport (Land Transport and Safety Authority, 2000). According to the New Zealand Children's Nutrition Survey data, over one-third of children walked or biked to/from school for a minimum of six trips each week, while nearly half of all children never commuted actively (Parnell et al., 2003). Statistics for New Zealand high school students is largely unknown. Although some data have been collected by Land Transport and Safety Authority, it has yet to be published. These data are a potential source for examining time trends for the youth population, and warrant further attention from the New Zealand physical activity research community.

Making direct comparisons between countries and surveys is problematic because of the variability in the questions used to assess travel habits. Using global questions regarding usual/typical mode of transportation over a predefine period requires a subjectively-determined answer. The validity of such questions, which are frequently employed, is not known. Assessing number of active trips over a short time period (e.g., past week), as employed in the New Zealand Children's Nutrition Survey

(Parnell et al., 2003), potentially provides a more objective criterion to determine actual frequency of active transit. A common exclusion across national level epidemiological studies is the assessment of intensity and duration of active transportation. The product of frequency and duration would provide a greater indication of active transportation engagement, compared to frequency data alone.

Conclusion and Future Research

Several opportunities exist for youth to be active on a daily basis. Despite this, a large proportion of children and young people are not as active as they could be. Each time and domain specific physical activity merits attention in future initiatives targeting increased physical activity. This is particularly so because people who engage in multiple physical activities across different domains typically achieve higher, but recommended, levels of physical activity (Giles-Corti & Donovan, 2003).

Considering the noticeable decline in physical activity participation during the high school years, youth is a population group that requires more attention from the research community, both nationally and internationally. Even though substantial epidemiological evidence exists, the majority of data have been survey-based with few studies examining physical activity objectively. A large body of evidence examining participation in sport and active transportation exists, while less is known about physical activity habits during recess and after-school time periods.

To date, research has typically examined each context of physical activity in isolation. Thus, little investigatory research has been conducted into the relative association between contexts or the potential contribution each context makes toward total daily activity levels for the high school population. Such evidence will assist in the identification of key physical activity contexts that might be targeted in future physical activity health promotion initiatives.

Epidemiological data specific to the New Zealand high school population are severely lacking, particularly in terms of active transportation, recess physical activity, and after school physical activity participation. While some physical activity data are available on young people up to the age of 14, data representative of all age groups represented at high school are sparse.

Furthermore, at conception of this thesis, no published New Zealand based studies have examined high school students' physical activity habits using an objective measure. Such evidence will add to the current knowledge base by overcoming the subjective limitations inherent in survey derived data.

To add to the current knowledge, one aim of this thesis is to examine participation levels of high school students in active transportation, recess physical activity, and after-school physical activity, and determine the level of association of participation levels across the various physical activity contexts. In addition, pedometer data will be collected among a sample of 12 to 18 year old high school students, a first for New Zealand research.

Chapter 5: Correlates of Youth Physical Activity

As highlighted in Chapter 4, some young people are sufficiently active, but the majority are not. This finding prompts the question ‘what influences young people to engage (or not) in physical activity?’ Correlates (and determinants) of physical activity can be grouped into one of two broad categories - individual (e.g., biological, personal, psychological factors) or environmental (e.g., social, physical, economic, policy). Gaining a better understanding of such correlates will help address the health priority of increasing physical activity among youth in New Zealand. In sequential order, Chapter 5 presents a brief overview of:

1. theoretical models and frameworks of behaviour;
2. individual correlates of youth physical activity;
3. social environmental correlates of youth physical activity;
4. physical environmental correlates of youth physical activity; and
5. future research directions.

Theoretical Models and Frameworks of Behaviour

Several theories, frameworks, and conceptual models have been developed to guide our understanding of the factors that influence people to engage in and maintain various health behaviours. While the Social Cognitive Theory (Bandura, 1986) highlights the interplay between individuals, environments, and behaviours (i.e., reciprocal determinism), the majority of early theories and models (e.g., Transtheoretical Model, Theory of Planned Behaviour) focused predominantly on individual factors (e.g., attitudes, cognitions). Subsequent intervention work, therefore, concentrated on person-level approaches (e.g., education, one on one counselling) and strategies (e.g., stimulus control, reinforcement) to change behaviour (Sallis et al., 2006). Whilst short-term success is often achieved, individual-level approaches are ineffective in achieving long-term changes (Dzewaltowski, Estabrooks, & Glasgow, 2004) or achieving population-wide changes in behaviour (Sallis, Bauman, & Pratt, 1998).

A short fall of early theories and models (and interventions) was that contextual and environmental factors were often not considered, or when noted were not considered fully (Kahn et al., 2002; King, Stokols, Talen, Brassington,

& Killingsworth, 2002). Interventions (and models) that focus on modifying the environment have potential to influence large groups (even populations) and therefore have the greatest promise in achieving population-wide changes (Brownson, Baker, Housemann, Brennan, & Bacak, 2001; Sallis et al., 1998) that are cost-effective and sustainable (King et al., 2002). Moreover, behavioural theories were initially developed to understand correlates of current behaviour rather than understanding behaviour change. Thus, the applicability of the theories to people moving from a sedentary to more active state was reduced.

The interest in measuring the environment and its impact on physical activity patterns has gained momentum over the past 20 years. Initially, research focused on proximal environments (e.g., family) and socio-environmental characteristics (e.g., social support). More recently, the focus has shifted toward examining policy, physical, and economic characteristics of more distal environments (e.g., neighbourhoods). While a surge of new research has emerged, the majority of evidence is relevant to only the adult population.

Without doubt, accurately measuring the characteristics of the environment we live in and its associated impact on physical activity is required. To gain a holistic understanding of physical activity determinants, an ecological approach is required. The premise underpinning ecological models is that both individual and environmental factors are important shapers of physical activity behaviours. Whilst a change in either factor can exert an effect on the other, modifying the environment (rather than the individual) is considered a more efficient means of achieving a good individual-environment fit (Spence & Lee, 2003). With this in mind, emphasis is now being placed on understanding broader, multi-level, ecological frameworks of physical activity health promotion (Sallis et al., 2006). The 'Youth Physical Activity Promotion' model (Welk, 1999) and the 'Ecological Model of Physical Activity' for youth (Spence & Lee, 2003) are both ecologically based.

From a youth perspective, aggregation of familial activity and peer activity is apparent (Aarnio, Winter, Peltonen, Kujala, & Kaprio, 2002; Duncan, Duncan, Strycker, & Chaumeton, 2004). Although congruent family activity is a likely by-product of genetic factors (Perusse, Tremblay, Leblanc, & Bouchard, 1989), researchers have acknowledged that the shared environment is an important contributor of the similar activity and inactivity phenotypes within

families and between friends (Perusse, Leblanc, & Bouchard, 1988; Simonen et al., 2002). Thus, to understand behaviour change among children and youth, research needs to go beyond individual factors, and consider the broader physical and social environments in which individuals and behaviours are embedded. Literature relating to specific individual and environmental factors will now be presented.

Individual Factors

Age, Gender, and Maturation

Research has consistently shown that males more active than females and that physical activity levels decline during adolescence (Duncan et al., 2007b; Kimm et al., 2002; Kimm et al., 2000; Sallis, 2000; Tammelin et al., 2007; Telama & Yang, 2000; Van Mechelen et al., 2000). From a biological perspective, the age-related decline is a potential trade-off to conserve energy for the demands of growth and maturation during adolescence (Goran, Gower, Nagy, & Johnson, 1998). Supporting this perspective, a study of adolescents between ages 12 and 22 showed that late maturers displayed higher physical activity levels than early maturers (Kemper, Post, & Twisk, 1997). Moreover, when biological age (i.e., years from peak height velocity) was examined, the apparent sex difference noted by chronological age disappeared (Sherar, Esliger, Baxter-Jones, & Tremblay, 2007; Thompson, Baxter-Jones, Mirwald, & Bailey, 2003). While a nonmodifiable biological reason is probable, low physical activity among adolescents is likely compounded by other environmental determinants which promote physical inactivity over physical activity.

Ethnicity and Socioeconomic Status

The reasons underpinning ethnic differences in physical activity remain unclear. While acculturation factors influence physical activity behaviours (Crespo, Smit, Carter-Pokras, & Andersen, 2001a; Evenson, Sarmiento, & Ayala, 2004), minority or native people who tend to be more inactive are also typically the most economically deprived. Thus, ethnicity and socioeconomic status are interwoven concepts which are difficult to disentangle, consequently hampering the ability to determine the relative contribution of each in shaping physical activity behaviours. An early study among an ethnically diverse sample of 286 youth in America found that access to exercise facilities and programmes

was shown to mediate the ethnic-related difference in physical activity levels (Garcia et al., 1995). This finding highlights the larger impact of socioeconomic status (rather than ethnicity) on physical activity levels. Moving forward, the investigation of intraethnic (rather than interethnic) differences is warranted to help determine factors that influence some people from a specific ethnic group to be active while their fellow peers are not.

Psychological Correlates

Several psychological constructs are positively associated with physical activity participation. Reviewing 108 studies conducted between 1970 and 1998, Sallis, Prochaska, and Taylor (2000) reported that intention to be active and perceived barriers (inverse) were consistently associated with physical activity during childhood. For adolescents, consistent association with perceived activity competence, intentions, depression (inverse), and sensation seeking were reported. Elaborating on this review and employing the same methodological approach, Van Der Horst, Paw, Twisk, and Van Mechelen (2007) reviewed articles published between January 1999 and January 2005. Self-efficacy was a consistent and positive correlate of physical activity among both children and adolescents. In addition, attitudes and goal orientation/motivation were associated positively with adolescent physical activity.

As mentioned earlier, theoretical models have guided correlate- and determinant-based physical activity research. Self-efficacy, a common construct represented across several theoretical frameworks, is believed to influence the activities in which individuals choose to participate in, effort expended on the activity, and the degree of persistence in participation in the face of failure or adverse stimuli (Bandura, 1986). Self-efficacy is one of the strongest and most consistent psychological correlate of youth physical activity which has been shown to have a direct (Motl, Dishman, Saunders, Dowda, & Pate, 2007; Motl et al., 2002; Motl et al., 2005a; Neumark-Stzainer, Story, Hannan, Tharp, & Rex, 2003; Strauss, Rodzilsky, Burack, & Colin, 2001; Trost et al., 1997; Trost et al., 2003; Wu & Pender, 2002; Wu, Pender, & Noureddine, 2003) as well as a mediating influence on youth physical activity (Beets, Pitetti, & Forlaw, 2007). Among 259 rural adolescent girls, greater barrier self-efficacy was found to partially mediate the association between peer social support and self-reported physical activity (Beets et al., 2007). Thus, having peers who provided support

to be physically active appeared to result in individuals having higher self-efficacy to overcome potential obstacles to participating in physical activity. In a longitudinal study, barrier self-efficacy was found to mediate the link between perceived equipment accessibility and physical activity levels over a one-year observation among 1038 adolescent girls (Motl et al., 2005a). This finding supports the premise underpinning the Social Cognitive Theory, in which the environment, person, and behaviour are intertwined.

According to the Theory of Planned Behavior (Ajzen, 1991), intention and perceived behavioural control directly influence people's behaviour. Intention, in turn, is influenced by perceived behavioural control, attitude, and subjective norms. Cross-sectional and prospective longitudinal studies have provided support for the Theory of Planned Behaviour factors hypothesised to influence intentions to be active (Hagger, Chatzisarantis, & Biddle, 2001a; Kerner & Kurrant, 2003; Motl et al., 2002; Mummery, Spence, & Hudec, 2000; Trost, Pate, Ward, Saunders, & Riner, 1999a; Trost, Saunders, & Ward, 2002b), particularly for perceived behavioural control. Some support for the intention - physical activity connect also exists, but the variance explained by intention is typically small (Godin, Anderson, Lambert, & Desharnais, 2005; Godin & Shephard, 1986; Hagger et al., 2001a; Kerner & Kurrant, 2003; Reynolds et al., 1990; Trost et al., 2002b).

Among the many theoretical frameworks, Social Cognitive Theory (SCT) has been frequently examined. It is also perceived by researchers to be the most theoretically sound as it considers the reciprocal relationships between the person, environment, and behaviour. The broad scope of the SCT allows the measurement and analysis of an infinite number of variables. Consequently, a large quantity of variance in physical activity (Petosa, Hartz, Cardina, & Suminski, 2005; Petosa, Suminski, & Hartz, 2003) has been accounted for by SCT-related variables. For a sample of youth at a mid-western city school four variables, collectively, accounted for 31% of the total variance in MVPA. Self-regulation accounted for the greatest quantity of total variance (24.6%), followed by skills/ability self-efficacy (2%), barrier self-efficacy (1%) and outcome expectations (2%) (Petosa et al., 2005). Noting these findings, the Social Cognitive Theory is considered to have the greatest utility and applicability to understanding behaviour and behaviour change.

Despite being separate theories, studies implementing structural equation modeling techniques have revealed that the constructs in the aforementioned theories are related (Dishman et al., 2006; Hagger, Chatzisarantis, Biddle, & Orbell, 2001b; Motl et al., 2002). Among a cohort of 431 high school students, goal setting and intention were found to mediate the link between self-efficacy and change in physical activity between 9th and 12th Grade (Dishman et al., 2006). While the existence of a goal was assessed (i.e., is physical activity a goal of theirs), specific detail about the goal behaviour was not, a limitation future studies should endeavor to overcome. For adolescent girls, Motl and Colleagues (Motl et al., 2007; Motl et al., 2002; Motl et al., 2005a; Motl et al., 2005b) noted that perceived behavioural control and self-efficacy were related to VPA and MVPA, respectively. Moreover, while self-efficacy, accounted for the effect of intention on physical activity using cross-sectional data (Motl et al., 2002), perceived behavioural control predicted change in VPA across a one-year period, while self-efficacy did not predict change in either MPA or VPA (Motl et al., 2005b).

The above findings show that an array of psychological predictors of physical activity exists. In alignment with the call from Baranowski, Anderson, and Carmack (1998), future studies (especially those examining environmental factors) should build upon existing psychological constructs and theories.

Sedentary Behaviours

Among the numerous sedentary pursuits available, time engaged with small-screen technology (e.g., TVs, videos, DVDs, computers, console games) has been predominantly examined. Today's technology-saturated living environment has likely contributed to youth, worldwide, displaying suboptimal levels of physical activity. According to the displacement hypothesis, sedentary behaviours are hypothesised to displace time that could be spent in more active pursuits.

Although intuitively logical, evidence supporting the displacement hypothesis is equivocal (Marshall et al., 2004; Scragg et al., 2006), particularly when total physical activity is examined. Several studies have failed to find an association (Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998; Gray & Smith, 2003; Hernandez et al., 1999; Robinson & Killen, 1995; Sjolie & Thuen, 2002; Utter, Neumark-Sztainer, Jeffery, & Story, 2003). A six-month intervention study

aimed at reducing TV viewing in children achieved reductions in anthropometrical indicators but had no effect on MVPA levels (Robinson & Killen, 1995). Other studies, however, have documented evidence of the displacement hypothesis (Bungum & Vincent, 1997; Crespo et al., 2001b; Eisenmann, Bartee, & Wang, 2002; Hancox, Milne, & Poulton, 2004; Koezuka et al., 2006; Lasheras et al., 2001; Lowry, Wechsler, Galuska, Fulton, & Kann, 2002; Motl, McAuley, Birnbaum, & Lytle, 2006; Pate, Heath, Dowda, & Trost, 1996; Santos, Gomes, & Mota, 2005; Vilhjalmsson & Thorlindsson, 1998). Data from the Northern Finland Birth Cohort Study showed that at age 15, Finnish males and females who watched TV for at least four hours per day were, respectively, 2.5 times and 1.6 times more likely to be inactive compared to their peers who watched less than one hour per day. A similar trend was noted for computer use also (Tammelin et al., 2007). Focusing on leisure-time physical activity, girls (but not boys) who reported no leisure-time physical activity reported significantly more screen time (Mota, Gomes, Almeida, Ribeiro, & Santos, 2007). This finding indicates that a gender difference may exist and that youth can be considered 'techno-active', that is they display high levels of both physical activity and TV viewing/video game usage (Biddle et al., 2003).

When positive findings are found, the magnitude of the relationship is typically weak. An outcome exacerbated by the difficulty in obtaining accurate measurement of physical activity among youth as well as typically assessing sedentary behaviour with a single marker (e.g., TV watching). When the purpose of engagement was assessed, sedentary activities categorised as productive (e.g., reading, homework) were found to be associated with more active youth (Feldman, Barnett, Shrier, Rossignol, & Abenhaim, 2003; Utter et al., 2003).

The inclusion of other sedentary behaviours prominent in a teenager's life (e.g., talking on the phone, texting) is required to provide a more holistic view of sedentary behaviour. In line with this perspective, researchers have started to investigate the association between time spent sitting and physical activity levels, rather than examining specific sedentary behaviours. A Sweden-based longitudinal study found that, in spite of less frequent physical activity habits over a six-year period (between ages 15 and 21), a reduction in daily sitting appeared to be a major reason why high levels of physical activity and energy expenditure, as assessed by a 7-day activity diary, were maintained

during late adolescence (Bratteby, Sandhagen, & Samuelson, 2005). From a public health perspective, promoting a decrease in total sedentary behaviour, rather than specific sedentary behaviours, is a more digestible recommendation for the lay population.

The weak findings of the displacement hypothesis is intensified by examining weekly levels of physical activity and sedentariness because during each week there is sufficient time to achieve high engagement in both physical activity and sedentary behaviours. For that reason, the displacement hypothesis is more likely to be relevant during periods where time is limited (e.g., the after-school period), competition between sedentary and active pursuits is magnified, and a choice between either pursuit is required. Albeit a few studies, evidence supporting this line of investigation exists. Hager (2006) reported significant negative associations between TV viewing and activity counts for male participants during the after-school time period. No significant associations were found on weekend days, a time period within which sufficient time to engage in both active and sedentary pursuits is available. Among 15 and 16 year olds from the Northern Finland Birth Cohort, those who reported high TV viewing and computer use were associated with lower levels of physical activity outside school hours (Tammelin et al., 2007). Similarly, Canadian youth between aged 12 to 19 years old who spent more than 21 hours per week viewing TV (i.e., 3 hours per day) were at least 1.36 times more likely to be considered inactive (i.e., not achieving 60 minutes of MVPA per day through leisure time physical activity) when compared to peers who watched less than six hours per week (Koezuka et al., 2006). Further investigatory research of the displacement hypothesis using a segmented day approach is warranted. Such research will help strengthen the case of the sedentary-physical activity link as well as determine if young people are maximising all opportunities to be active.

Despite the absence of a consistent sedentary-physical activity connect, most young people exceed the recommended daily level of screen-use (Spink et al., 2005; Tammelin et al., 2007; Vaughan et al., 2007). Reducing the time young people spend being sedentary is an important strategy and health priority. A reduction in sedentary behaviour will help free-up time for youth to engage in more active pursuits. Utilising the free time to be active, however, will required the environment to be supportive of, and make participation in, regular activity an accessible option.

Physical Environment

During the past decade, the impact of the physical environment on physical activity behaviour has become a popular and ever-growing line of investigation. Distinct aspects of the physical environment have been studied to varying degrees across different population groups. For adults, several review articles have purported that local destinations, safety, aesthetics, and functionality are all neighbourhood characteristics that influence physical activity behaviours, with walking, leisure time physical activity, or overall physical activity typically assessed (Badland & Schofield, 2005; Brug, van Lenthe, & Kremers, 2006; Cunningham & Michael, 2004; Duncan, Spence, & Mummery, 2005; Eyler, Brownson, Bacak, & Housemann, 2003; Heath et al., 2006; Humpel, Owen, & Leslie, 2002; McCormack et al., 2004; Transportation Research Board and Institute of Medicine, 2005). While informative, review articles are typically limited by their narrative (rather than systematic) review process, tend to lean towards a positive bias as a result of the narrative stance as well as incorrect reporting of results, and at least one-third of studies that could be eligible are often omitted (Gebel, Bauman, & Petticrew, 2007). While reviews often portray the physical environment as an important contributor, mixed findings are evident.

Compared to adult studies, investigatory research on the physical environment - physical activity relationship among the adolescent population is sparse. Prior to 1999, over 40 determinants of adolescent physical activity had been examined, of which only seven were related to the physical environment (Sallis et al., 2000). Whilst it is anticipated that the physical environment will be influential, it is premature to assume that the impact will be identical for children, youth, and adults. The following sections provide a brief overview of a selection of physical characteristics relating to the home, school, and neighbourhood settings.

Home Environment

To date, a handful of studies have examined the following physical feature of the home setting: availability of TVs, vehicle ownership, and presence of exercise/sport equipment. An early study on 110 college students revealed that from a list of 43 self-report items used to assess

environmental variables at home, in the neighbourhood, or on frequently travelled routes, the only significant association existed between availability of home equipment and participation in strength exercises (Sallis, Johnson, Calfas, Caparosa, & Nichols, 1997). Among minimally active adolescent girls, their perceptions of resource availability in both the home and community settings were positively associated with cardiovascular fitness but unrelated to VPA, daily energy expenditure, and lifestyle activities. Adolescents, however, are more attuned to and more likely to use the resources for physical activity located in their home as opposed to wider community environment (Dunton, Jamner, & Cooper, 2003). In terms of active transportation, child focused studies have documented a negative relationship between household vehicle ownership and walking/cycling to and from school (Carlin et al., 1997; DiGuiseppi, Roberts, Li, & Allen, 1998; Roberts et al., 1997) and to local destinations (Timperio, Crawford, Telford, & Salmon, 2004).

School Environment

A compulsory destination for most young people on all weekdays during the school term is their school. School characteristics have been shown to impact on physical activity undertaken during school hours, but also outside school hours.

Outside school hours, schools provide a destination in which student can commute actively to. Physical distance, however, inhibits primary and secondary school students commuting actively to school (Dellinger, 2002; Timperio et al., 2006) with research showing that students attending small sized schools that are situated within walkable neighbourhoods are more likely to walk to school than students attending large schools in remote areas (Ewing, Schroeder, & Greene, 2004). Similarly, students attending private schools are less likely to use active travel (Carlin et al., 1997; Roberts et al., 1997). This finding is a potential consequence of differing enrolment processes. At private schools enrolment is not restricted by zoning regulations (as are public schools). Therefore, many privately schooled students are likely to travel from beyond the local school area to attend. Other physical factors (e.g., travel time, household vehicle ownership, driver's licence ownership) may have also affected modal choice noted in the aforementioned studies.

In contrast to active transport - school size association, when physical activity during school hours is measured, larger schools appear to demonstrate a more positive association. Among middle school students, larger school campuses, school buildings, and play areas (per enrolled student) were associated with higher levels of objectively-assessed physical activity during school hours. This activity difference equated to an extra two miles of walking per week (Cradock, Melly, Allen, Morris, & Gortmaker, 2007). These findings are limited by the typically small and homogenous samples and the inability to determine the contribution school activity programming may have had on observed physical activity levels.

The noted findings highlight that the built environment may be considered an attribute or not (e.g., large school size) depending on the physical activity domain or context examined. Before informing policy, future research on the association between physical school characteristics and physical activity is warranted.

Neighbourhood Environment

Among environmental settings, the local neighbourhood has received substantial research attention, with urban form being linked with some physical activity domains and health outcomes (Ewing, Schmid, Killingsworth, Zlot, & Raudenbush, 2003). The buffer zones used to define a local neighbourhood has differed across studies with little agreement regarding what might constitute an appropriate buffer zone (Giles-Corti, Timperio, Bull, & Pikora, 2005b). To date, distance (e.g., 400m, 1-mile), time (e.g., 10-15 minute walk, 20 minutes drive), and nondistance, nontime (e.g., within walking distance) boundaries have been employed (Frank, Andresen, & Schmid, 2004; Giles-Corti et al., 2006; Norman et al., 2006; Saelens, Sallis, & Frank, 2003; Utter et al., 2006). Highlighting the importance of buffer zones definitions, a recent study found that the links between park, crime, and gym variables differed according to the approach used to code and define a buffer zone - 400m, 1-mile, or nearest distance criteria (Jago, Baranowski, & Harris, 2006).

Acknowledging this inconsistency between studies, neighbourhood characteristics researched to date include access and availability of outdoor space/activity locations, functionality, safety and aesthetics.

Outdoor Space and Local Destination Access and availability of local public spaces and utilitarian destinations have been associated with physical activity among adults and older adults (Giles-Corti et al., 2005a; Giles-Corti & Donovan, 2002b; King et al., 2003). Access to attractive, large public open space and parks was related to walking among Australian adults (Giles-Corti et al., 2005a). Engaging in sufficient levels of leisure-time physical activity was positively related to trails and activity locations among adults in North Carolina (Huston, Evenson, Bors, & Gizlice, 2003). This positive association appears true for the youth population also.

As most young people are not of the legal age to drive, local recreational infrastructure become important venues where young people can be physically active (Sallis et al., 2000). Reviewing available literature, Sallis and colleagues (2000) found higher physical activity levels among children who spent more time outdoors and had better access to facilities and programmes, and for adolescents in particular, had more opportunities to exercise. While this review is limited to six studies conducted prior to 1999, recent research provides further support of the impact local destinations have on youth activity levels.

As with adults, outdoor recreation facilities, parks, and other activity locations are positively related to physical activity among youth (Evenson, Scott, Cohen, & Voorhees, 2007; Norman et al., 2006; Utter et al., 2006; Zakarian, Hovell, Hofstetter, Sallis, & Keating, 1994). Among American adolescent girls, those who reported having more than nine activity locations to go to achieved higher MVPA levels than their peers who reported four or fewer locations (Evenson et al., 2007). Based on national data, middle and high school students in the United States who used community recreation centers were 1.75 times more likely to engage in high levels of MVPA (Gordon-Larsen et al., 2000). Examining a variety of activity locations, New Zealand data indicated that perceived access to various activity locations within walking distance of high school student's homes was significantly associated with engaging in regular VPA (Utter et al., 2006).

Among activity locations, parks have been consistently and positively associated with physical activity (Cohen et al., 2006). For young children aged four to seven years old, park and recreation space accounted for 10%

of variability in accelerometer-determined activity levels. This was additional to the 12% accounted for by housing density (Roemmich et al., 2006). Among older children aged eight to 15 years old, greater park access was associated with greater levels of physical activity when a reduction in sedentary behaviour was targeted (Epstein et al., 2006). Adolescent girls who lived near more parks (especially parks with amenities that are conducive to walking and with active features) were found to engage in more nonschool metabolic equivalent-weighted MVPA than those with fewer parks (Cohen et al., 2006). While only equating to an average of 4% to 6% of a girl's total nonschool metabolic equivalent-weighted MVPA, at a population level small changes in activity are likely to have a large effect. Although these studies highlight a park access-physical activity association, whether the parks were used for physical activity was not assessed.

Accessibility of local neighbourhood shops, food outlets, and convenience stores may also influence young people's daily walking behaviour undertaken for utilitarian duties (e.g., getting milk for mum). Among Portuguese youth, active youth perceived access to local shops to be easy compared to their nonactive peers (Mota, Almeida, Santos, & Ribeiro, 2005). However, the proportion of daily activity contributed to by utilitarian duties was not determined. Considering the current obesity epidemic, promoting the development of local shop without considering the destinations attributes could counteract the benefit of walking to such destinations. Thus, advocating for local destinations should be considered in light of the destinations attributes.

Functionality Neighbourhood functionality includes characteristics such as mixed land use, residential density, street connectivity, and pedestrian friendly designs (e.g., presence of sidewalks). When combined, a composite measure is formed that provides an indication of neighbourhood functionality (e.g., the walkability index, sprawl index). Using composite measures, neighbourhoods can be categorised as walkable or nonwalkable. Walkable neighbourhoods consist of high residential density, mixed land use, good street connectivity, and pedestrian friendly aesthetics and designs.

Supporting the move towards integrated communities, literature suggests density, street connectivity, and mixed land use are positively related to walking behaviours among adults (Booth, Owen, Bauman, Clavisi, & Leslie, 2000;

Craig, Brownson, Cragg, & Dunn, 2002; Giles-Corti & Donovan, 2003; Humpel et al., 2004b; Pikora et al., 2006; Saelens et al., 2003; Troped, Saunders, Pate, Reininger, & Addy, 2003). Among older adults, access to local facilities and presence of sidewalks was shown to increase their odds of being considered active (Booth et al., 2000). Several functionality variables, but not visual interest and aesthetics, were positively associated with active transportation to work among Canadian adults (Craig et al., 2002). Based on one community in the Netherland, the square area of sport grounds and parks were found to be associated with time spent cycling among adults (Wendel-Vos et al., 2004). Another study showed that living in more pedestrian-friendly neighbourhoods (i.e., homes built between 1950 and 1969) and living within walking distance of specific types of businesses and facilities were positively associated with pedometer-determined physical activity levels (King et al., 2005).

The attributes of the physical environment appear to have differential impact depending on the purpose for which the activity was undertaken (Hoehner, Brennan Ramirez, Elliott, Handy, & Brownson, 2005; Humpel, Owen, Iverson, Leslie, & Bauman, 2004a; Lee & Moudon, 2006; Oakes, Forsyth, & Schmitz, 2007). Oakes, Forsyth, and Schmitz (2007) reported that walking for transport purposes was associated with areas of higher-density while low connectivity was associated with increased odds of doing leisure-time walking. Neither density nor street connectivity was meaningfully related to overall mean miles walked per day or total physical activity. Noting this finding, the authors concluded that the effects of density and block size on total walking and physical activity are modest to nonexistent (Oakes et al., 2007).

For youth, neighbourhood functionality appears to be linked to youth physical activity. In the United States, students (Grade 4 to 12) whose neighbourhood had sidewalks were 3.4 times more likely to walk or bike to school (Fulton et al., 2005). This finding was not adjusted by locality (rural versus urban) which may have moderated the observed relationship. Among primary school children, actively commuting to school was less likely to occur if their route was greater than 800 meters and if a busy route barrier was present en route (Timperio et al., 2006). An earlier study reported that active travel was associated with population density but not connectivity among children (Braza, Shoemaker, & Seeley, 2004). Thus, this finding indicates a potential difference in the connectivity-walking relationship by age (adults versus children). The

California Safe Routes to School (SR2S) legislation provides competitive funds for construction projects such as sidewalks, traffic lights, pedestrian crossing improvements, and bicycle paths. Using a natural experiment design, this policy-related study showed support for developing walkable neighbourhoods (Boarnet, Anderson, Day, McMillan, & Alfonzo, 2005). In particular, based on parental reports, children who passed completed SR2S projects were more likely to show increases in walking or cycle travel than were children who did not pass by projects (15% versus 4%, respectively).

The association between functionality and physical activity behaviours is still under debate. Methodological differences between studies, the paucity of research, and lack of understanding of the environmental design features that might influence activity behaviours partially account for this ongoing debate. Further evidence is needed to confirm or refute this hypothesised physical environment – physical activity association. Confirmation of specific characteristics associated with increased activity across multiple population groups is required before specific characteristics can be advocated to government. If found to be influential, determining the cost-effectiveness of re-developing built environments that discourage physical activity will be required (Fulton et al., 2005; Tudor-Locke, Ainsworth, & Popkin, 2001) to gain Government buy-in and to help inform future policy relating to neighbourhood developments.

Safety Although the physical dimensions of a neighbourhood may assist with greater opportunities for leading a physically active lifestyle, the level of neighbourhood safety, whether perceived or real, is a potential barrier hindering adolescents' access to their neighbourhood. Safety is a complex concept consisting of both social and physical dimensions. As a consequence, a multitude of items (e.g., people loitering, presence of gangs, crime, traffic) and composite measures (e.g., it is safe to walk/jog in my neighbourhood), including both subjective and objective measures, have been used to capture this construct.

Findings on the safety-physical activity link are mixed. Low perceived safety of the neighbourhood (as perceived by residents) and objectively assessed social disorder (but not physical disorder) were significantly associated with less proxy-reported physical activity among United States adolescents aged 11 to 16 years (Molnar, Gortmaker, Bull, & Buka, 2004).

Assessing perceived safety from adolescents or parents may have revealed different findings as their proximal views are likely to be more influential than that of their local residents. Among a large (n=1,634) sample of economically deprived minority 9th and 11th graders in America, perceived neighbourhood safety was not associated with frequency of engaging in VPA outside school hours (Zakarian et al., 1994). An earlier American-based study also failed to associate parental proxy reports of park safety or neighbourhood safety with VPA among students in Grades 1 through 12 (Sallis, Taylor, Dowda, Freedson, & Pate, 2002). The lack of association with VPA is a likely consequence of VPA typically occurring within a structured environment and during structured activities (e.g., sport team). Hence, the impact of safety is potentially reduced. The aforesaid studies are all American based with samples typically homogenous in characteristic. Thus, the applicability of the findings to other countries is limited.

Traffic and crime are two key barriers reported by parents that prevent their children from walking or biking to school (Dellinger, 2002). Among adolescent females (Grades 8 – 12) in the United States, no association between self-reported neighbourhood safety (i.e., traffic level and crime rate) and physical activity levels over a one-year period was reported (Mottl et al., 2005a). The relatively high level of, and low variability in, perceived safety scores may have influenced the reported outcome. Similarly, no significant differences in self-report perceptions of neighbourhood crime and traffic levels was found between active and nonactive females in Grades 7 through 12 (Mota et al., 2005). This finding is hampered by not controlling for socioeconomic status which has been linked with more active friendly environments. Likewise, self-reported perceived safety among younger girls (aged 8 to 10 years old) also failed to associate with objectively-determined physical activity levels (Adkins, Sherwood, Story, & Davis, 2004). When safety is assessed objectively, the opposite trend has been reported. In particular, high levels of objectively assessed serious neighbourhood crime was associated with a decreased likelihood of youth aged 11 to 21 years in the United States being categorised in the highest MVPA group (Gordon-Larsen et al., 2000). The lack of association of self-perceived safety with physical activity may reflect the potentially naive and inaccurate perspective young people hold about safety. Also, the level of

seriousness of the perceived safety items assessed was less when compared to the objective collected data.

Aesthetics Aesthetics, which encapsulate the appeal and attractiveness of the neighbourhood, has been measured both objectively and subjectively. For adults, perceived aesthetics of their local neighbourhood have been associated with higher levels of walking behaviour (Ball, Bauman, Leslie, & Owen, 2001) and active commuting (Troped et al., 2003). For youth, findings are limited and mixed.

Among American adolescent girls, physical activity (but not active transport to and from school) correlated positively with having interesting things to look at and the presence of garbage. Unpleasant smells in the neighbourhood correlated positively with active transport to and from school, but not total physical activity (Evenson et al., 2006). These contrapositive findings highlight that individuals who engage with the neighbourhood, whether for active reasons or not, will be more aware of its aesthetics, pleasant or not. Among young Portuguese females, having interesting things to look at in the neighbourhood was also found to be positively associated with self-report physical activity (Mota et al., 2005). Using an overall measure of tidiness, Jago et al (2005b) found no association with accelerometer-determined activity levels among a group of 210 boy scouts. Due to the dearth of evidence, the cross-sectional nature of the studies and lack of direct replications, strong conclusions cannot be made. Additionally, relationships based on perceptions need to be interpreted with caution because the reliability of self-reported neighbourhood characteristics by adolescents is not known (Utter et al., 2006).

Conclusion

Based on available evidence, the physical environment appears to be related to physical activity participation, with up to 12% of variance in physical activity explained by any single factor. Mixed findings are evident, which is intensified by several methodological limitations of current research. Comparatively, less is known about this relationship for youth than adults. Formulating conclusions about the physical environment - physical activity relationship among specific subgroups is impossible because few studies have identified potential moderators (Kremers, de Bruijn, Droomers, van Lenthe, &

Brug, 2007). Much work is still required to identify relevant environmental features, refine measurement tools, and better measure environmental exposure. A large task as thousands of environmental factors may influence physical activity behaviours, with each factor analysable by numerous characteristics (Ball, Timperio, & Crawford, 2006). Determining which of these factors are most important in influencing physical activity will be a challenge. Direct replication of studies is infrequent with current knowledge based predominantly on cross-sectional observational studies that lack the ability to determine causation. Nonvalidated measures are often employed, and multilevel analyses are rarely conducted (Brug et al., 2006). Few intervention studies have been conducted. As a consequence, one cannot determine whether people were more likely to be active or engage in active transportation due to environmental factors or whether people live where they do because of personal circumstances and preferences. Only when better designed and conducted research occurs will the true importance of environmental factors be determined (Brug et al., 2006).

Prospective studies that incorporate both objective and perception-based measures of the environment is advocated, as well as the evaluation of how the physical environment affects physical activity in different domains (Mota et al., 2005). Future studies should control for differing neighbourhood awareness levels so the true impact the physical environment has on physical activity can be determined. Carrying out natural experiments as well as intervention studies may help overcome the limitations associated with cross-sectional research (Brug et al., 2006; Diez Roux, 2003). As it is believed that environmental characteristics may impact physical activity behaviours differently in demographic subgroups (Duncan et al., 2005), future research should endeavour to identify the existence of differential impact across age groups.

From an intervention viewpoint, perceptions of the environment are highly individual irrespective if people have similar level of engagement with their neighbourhood. This poses a challenge for those advocating re-development of current built environments or devising policy and regulations around new suburban developments. Future studies examining the link between the physical environment and physical activity and how these associations differ (or not) across the human lifecycle are required.

Social Environment

Social support, a construct extensively researched, refers to the presence and nature of interpersonal relationships and interactions (McNeill, Kreuter, & Subramanian, 2006). Parents, siblings, cousins, aunts/uncles, grandparents, teachers, and friends are examples of support sources for young people, with most research focused on the impact parents and friends exert with little consideration of extended family members (e.g., cousins) or other social networks. Conceptually, support typologies are comprised of several elements, including role modelling, logistical support (e.g., providing transportation to an activity location), and encouragement. Each of these social constructs will now be examined.

Role Modelling

Role modelling, the most widely studied social construct, is operationalised as the association between physical activity levels of a support source (e.g., parent, mother, sister) and the adolescent or child. Slightly different to role modelling is the concept of dual-participation. Dual participation refers to significant others participating with their daughter, son, brother, sister or friend in physical activity. Both role modelling and dual participation are associated with physical activity among children and adolescents with active young people more likely to report that their parents, friends, and/or siblings participate in physical activity alongside them (Bungum & Vincent, 1997; Davison, 2004; Davison, Cutting, & Birch, 2003; Prochaska, Rodgers, & Sallis, 2002) or are considered physically active (Cleland, Venn, Fryer, Dwyer, & Blizzard, 2005; Duncan et al., 2004; Schofield, Mummery, Schofield, & Hopkins, 2007; Vilhjalmsson & Thorlindsson, 1998).

Parents The parent-child and parent-adolescent dyads of total physical activity levels are equivocal (Ferreira et al., 2006; Gustavsson, Thorsen, & Nordstrom, 2003). However, a consistent, positive parent-child dyad exists in terms of sport participation (Anderssen & Wold, 1992; Cleland et al., 2005; Gottlieb & Chen, 1985). Furthermore, children who have at least one parent active in sport, either as a participant or volunteer, were more likely to engage in regular sport participation, with even greater odds if both parents were actively involved (Kremerik, 2000). Explicit parental modelling may, therefore, have more influence on context-specific activities like sport participation rather than

overall activity (which can include incidental activity). This is not unlikely as parents who are active may provide more encouragement and exert greater influence towards out-of-school, structured activities like sport.

Siblings Congruent physical activity levels between siblings has also been reported (Duncan et al., 2004; Vilhjalmsson & Thorlindsson, 1998). Although genetic factors are also likely to influence the aggregation of familial activity (Perusse et al., 1989), researchers acknowledge that the shared environment is an important contributor to the observed familial congruence of activity and inactivity phenotypes (Perusse et al., 1988; Simonen et al., 2002).

Increasing independence from families and expanding social networks external to the family environment are key characteristics of adolescence (Eccles, 1999). During adolescence, time spent with friends typically increases and often outweighs time spent with family members. Thus, as young people move through adolescence peers are considered powerful influencers, more so than parents and siblings, (Anderssen & Wold, 1992; Wold & Anderssen, 1992).

Friends Active young people tend to have more active friends. This association has been found true for children (Moore et al., 1991) and adolescents (Anderssen & Wold, 1992; Davison, 2004; Davison et al., 2003; Saxena, Borzekowski, & Rickert, 2002; Stucky-Ropp & DiLorenzo, 1993; Wold & Anderssen, 1992), with a the strength of the association stronger among friends who report a reciprocal friendship than those who did not (Schofield et al., 2007).

Several limitations common across studies preclude the true strength of the role modelling hypothesis to be determined. Limitations include frequent use of cross-sectional designs, lack of direct methodological replication, and inability to generalise findings to minority populations because homogenous samples are often examined (Gustafson & Rhodes, 2006). Without longitudinal prospective studies, the direction of causation of the various dyads cannot be determined. To date, studies have focussed on positive role modelling. The impact of negative role modelling behaviour on youth activity levels should be considered in future studies (Gustafson & Rhodes, 2006).

Logistical Support

Supplying fees to join a sports team, enrolling a child in organised activities, providing transportation for a child to an activity location (e.g., park), and providing equipment to be active are all actions collectively referred to as logistical support. Even though not studied extensively, initial findings show a positive relationship with physical activity, especially for girls. Among youth, the act of providing transportation was linked with participation in organised sport/activity lessons (both boys and girls) and total physical activity levels (girls only) and explained between 1% to 5% of the variance in physical activity levels (Hoefer, McKenzie, Sallis, Marshall, & Conway, 2001). Parents have been found to differ in level of parental practices with mothers providing significantly higher levels of logistical support while, in contrast, fathers provided greater explicit role modelling.

Encouragement

Encouragement is a broad umbrella term and typically examined with a single generic question regarding the frequency of encouragement from the specific support source. For example, how often does your father encourage you to be physically active? While the use of a single question to assess encouragement is not ideal, pragmatically, it may be the only possible approach to employ. This is especially so in questionnaires where support is only one of the many variables measured, or when perceptions of encouragement are being assessed in relation to a number of support sources. What is actually measured is very much dependant on the participant's interpretation of the question. This interpretation may include encouragement by means of verbal, physical, and logistical support. Noting this limitation, such questions may be reflective of overall social support.

In light of the aforementioned limitations, like other forms of support, active children and youth typically received more encouragement to be active from their parents, siblings, and peers (Anderssen & Wold, 1992; Bungum & Vincent, 1997; De Bourdeaudhuij et al., 2005; McGuire, Hannan, Neumark-Sztainer, Cossrow, & Story, 2002; Springer, Kelder, & Hoelscher, 2006). The abovementioned studies, however, typically assessed intensity-based physical activity levels. It is likely that the influence of encouragement from different support sources will vary across the various physical activity domains.

Social Support

Like encouragement, another broad social construct is perceived social support. Consequently, social support has been examined using a single question or multiple questions which, when combined, form a composite measure of support (Beets et al., 2007; Davison, 2004; De Bourdeaudhuij et al., 2005; Neumark-Stzainer et al., 2003; Trost et al., 2003; Wilson & Dollman, 2007). While more holistic, composite measures overlook relative or cumulative effects of the individual support items collected.

As expected, social support is linked with youth activity. Trost and colleagues (2003) found self-perceived parental social support exerted a direct influence on parents offspring's self-reported physical activity and an indirect influence through their child's self-efficacy. Although the sample in this study consisted of young people spanning early-to-mid adolescence, age-dependent associations were not undertaken. Based on longitudinal data from a sample of adolescent females, the authors calculated that improved self-perceived social support levels could result in a 19-minute increase in MVPA per week (Neumark-Stzainer et al., 2003). While support from various sources (i.e., parents, peers, teachers) were measured in this study, a composite social support score was analysed. Consequently, the relative importance of social support from each support source was not determined.

While not social support *per se*, studies have examined the impact social aspects of the family environment have on youth activity levels. Good home quality (as defined according to level of home problems – very serious to very good) was associated with young people achieving physical activity guidelines. The mechanism(s) which underpin this association require further investigation. Based on the 1995 National Longitudinal Study of Adolescent Health data, several familial factors positively predicted youth achieving at least five sessions of MVPA per week one year later; these being family cohesion, parent-child communication, and parental engagement (Ornelas, Perreira, & Ayala, 2007). Likewise, greater connectedness to family and friends was linked with higher weekly bouts of VPA among youth living in Dunedin, New Zealand (Carter, McGee, Taylor, & Williams, 2007). With these findings in mind, family-based intervention targeting adolescent activity should consider the quality and atmosphere of the family environment. This line of investigation is of particular

importance for children and youth living in high-risk and potentially volatile family environments.

Family Composition

In New Zealand, family composition is changing with single parent households becoming more common. For certain ethnic groups (e.g., Pacific people), living with extended family members is common (Statistics New Zealand, 2002) and can lead to overcrowding (Statistics New Zealand, 2003). Family (nuclear family or extended family households) and parental (one parent versus two parent families) composition appear to be potential influencers of adolescent physical activity.

From available evidence, it appears that youth who have at least one parent who provides support is better than two parents providing negative influences (Gustafson & Rhodes, 2006). Davison, Cutting, and Birch (2003) reported that physical activity levels were higher among nine-year-old girls who reported higher levels of overall support from at least one parent (compared to no parents), and that no significant differences in physical activity were identified between one versus two parent households. In contrast, adolescents from single-parent homes reported participating in more sport than two-parent homes (Duncan et al., 2004). Sport may therefore provide a potential avenue for children from single parent homes to be supervised.

Among a sample of American high school students, those who never had a parent at home immediately after school were significantly more likely to walk to and from school (Evenson, Huston, McMillen, Bors, & Ward, 2003). Similarly, adolescent girls who reported low adult supervision during the after-school period were more active than those with adult supervision. An average of eight minutes more of MVPA was achieved by girls who were alone for more than two hours per day, on more than two days per week. Unsupervised girls also spent less time in cars but talked more on the phone, watched more television and did less homework (Rushovich et al., 2006). The impact that supervision (or lack thereof) had on after-school activity could not be determined because total physical activity was the outcome variable studied. Aside from supervision level, the association may have emerged from individual-level differences between low and highly supervised girls. Also, the absence of a parent is a likely reflection of household socioeconomic position, a variable shown to be

associated with physical activity engagement. Potential mechanisms underlying this supervision association requires investigation.

In addition to parental composition, the presence of siblings also appears to influence physical activity, at least for children. Among Australian children, those in single child households spent more minutes per day watching TV compared with same-sex peers who had siblings. Also, girls, but not boys, with siblings spent, on average, 17 more minutes per day in physical activity compared to only child participants who accumulated, on average, 131 minutes of physical activity. This sibling association may depend on the age spread among siblings, the order within which the sibling lies (i.e., oldest, middle, youngest), and the sex of the siblings.

While caution is advised when interpreting findings from these few studies (Gustavsson et al., 2003), available evidence indicates that family structure requires consideration too when devising interventions aimed at increased physical activity and reduced TV viewing. Tailored rather than generic family-based interventions are required to meet the specific needs of individual families. In today's environment, the once dominant two parent, nuclear family is declining with concurrent increase in single-parent families who are disadvantaged economically and socially when compared to two-parent families (Ministry of Social Development, 2006). With this in mind, further investigation of the potential influence of family composition on child as well as youth activity is warranted.

Relative Contribution: Individual versus Environmental Factors

Physical activity is shaped by a multitude of factors. Thus, debate exists regarding the relative and significant contribution individual versus environmental factors make toward predicting physical activity behaviour, but also the relative importance of the social and physical environmental characteristics. To inform this debate, ecological study designs have been employed to assess both individual and environmental factors simultaneously in adult (Giles-Corti & Donovan, 2003) and youth (Fein, Plotnikoff, Wild, & Spence, 2004; Motl et al., 2005a; Ommundsen, Klasson-Heggebo, & Anderssen, 2006; Sallis, Prochaska, Taylor, Hill, & Geraci, 1999; Sallis et al., 2002) focused research.

For adults, the Study on Environmental and Individual Determinants of Physical Activity (SEID project) conducted in Perth (Australia) indicated that from the 14 variables assessed, individual and social factors outweighed the role played by physical environmental factors in terms of adults achieving recommended physical activity levels through recreational activity (Giles-Corti & Donovan, 2002a). However, when a composite score for each determinant category (individual, social, physical) was formed, the categories were found to be equally important influencers of walking behaviour (Giles-Corti & Donovan, 2003). Thus, the importance of factors depends on the outcome variable of interest and the way the variables are examined. The noted findings from this study are limited by being based on a specific geographic location within Perth, thereby, limiting the generalisability of the findings as well as potentially reducing the variability in the variables measured. Also, while distance to various locations was assessed, the locations aesthetic characteristics were not, a factor which may influence the use of such destinations for recreational purposes. According to these data, the physical environment appears to be of more importance to walking than overall activity.

In terms of youth, a study of Norwegian boys aged nine and 15 years old reported that psychosocial (e.g., perceived support, perceived competence, physical activity enjoyment) and environmental (e.g., opportunity, facility, parental physical activity policies) factors accounted for 16% of the variance in active transportation, 44% for leisure-time physical activity, and 55% for school-located informal games. Most of the variance explained was accounted for by the psychosocial factors, with minimal change in the variance (1% to 3%) resulting from the inclusion of policy and physical environmental factors (Ommundsen et al., 2006). The findings are limited by the few items used to assess environmental factors, resulting in reduced reliability. Also, physical activity was assessed subjectively with a survey that requires further validation.

Only when more ecological based study designs are implemented with robust measurement tools will evidence informing this debate be ascertained. Until then, much more research is required to elucidate the true contributions individual, social environmental and physical environmental factors play in shaping physical activity behaviours.

Conclusion, Limitations, and Future Research

Physical activity among youth is influenced by a complex mixture of variables. The strength of the observed associations is typically moderate at best; reflecting the difficulty in obtaining accurate physical activity data and that youth activity is influenced by a multitude of factors. Despite this, individual, social, and environmental variables, collectively, have been shown to explain up to 59% of variance in youth physical activity (Sallis et al., 1999; Sallis et al., 2002).

Examining the impact of the physical environment on physical activity behaviours has become popular among researchers worldwide. Caution is required before advocating for specific environmental characteristics. A main reason for this cautionary stance is that there is a dearth of current evidence, especially across multiple population groups within which the relationship may differ substantially. Identifying common characteristics across groups needs to be examined further to help prioritise environmental characteristics to target.

In terms of the social environment, current literature has focused predominantly on two sources of support, parents and friends, with little consideration of encouragement provided by siblings, extended family members (e.g., cousins), and schools. The influence of the extended family network, a family structure common among certain ethnic groups in New Zealand, has also received little attention from the physical activity research community. Likewise, parent type (i.e., no parents, two parent family, single parent family, etc.) has rarely been considered, despite the apparent economical and social disparities noted between different parent structures (Ministry of Social Development, 2006).

Among social support studies, there has been a lack of diversity in the outcome variable assessed. Participation in VPA or MVPA has typically been examined with little attention directed toward activities undertaken at specific time periods or segments of a school day (e.g., after-school activity, lunchtime activity, before school as part of active transportation). Ecological models posit that influencers most proximal to the target group will have the strongest effect on the desired behaviour (Spence & Lee, 2003). Thus, the importance of support from parents, friends, siblings, and schools is likely to be dependent on the location, period of the day, and context of the physical activity examined; a perspective that has yet to be investigated.

Among the correlates examined, social (other than role modelling), policy and physical environmental factors are among the least studied. When studied, they often represent a single microenvironment (e.g., home, school, neighbourhood), limiting one's ability to determine the relative importance of various settings that are proximal to the youth population. Research on social, policy, and physical environment items that represent different settings may highlight the setting which has the greatest influence potential to increase physical activity among youth.

To overcome the identified gaps in literature, a key part of this thesis is to simultaneously examine the importance of perceived encouragement from parents, older siblings/cousins, friends, and schools on participation in various opportunistic time periods which are available in a school day (e.g., after-school physical activities, lunchtime physical activity, engagement in active transportation to and from school).

Chapter 6: Pedometer-Determined Physical Activity Levels of Adolescents

Preface

The literature presented in Chapter 4 highlighted that objectively-determined physical activity data are scarce, particularly among the youth population, with no New Zealand specific data currently available. Objective measurement tools, like pedometers, are becoming the method of choice for capturing total physical activity levels, as they overcome the reliance on people's perceptions and memory which are widely noted limitations of commonly employed survey methodology. The research outlined in this chapter helps minimise this large knowledge gap by describing habitual physical activity levels, through daily pedometer step counts, of a sample of youth in New Zealand aged 12 to 18 years. The objectives of the study were to describe daily activity levels and determine differences by age, sex, transportation mode to and from school, and by time of week. This study also aims to determine the proportion of students who met the widely publicised criterion of 10,000 steps per day, a threshold which represents an active lifestyle among adults albeit a conservative criterion for youth to achieve despite the commonly reported decline in physical activity during adolescence. Because of the relatively small sample size (although similar to other pedometer studies) and demographic make-up of this sample, generalisability of the findings to the wider New Zealand youth population must be made with caution. Despite this, the data presented are the first New Zealand specific pedometer data for high school students, adding to the current knowledge of activity among youth in New Zealand.

Introduction

Increasing physical activity among youth is a priority in many countries, including New Zealand (Ministry of Health, 2003a). Around the globe, knowledge about youth physical activity behaviours is based predominantly on survey-derived data, a measurement method associated with well-described limitations (Kohl III et al., 2000; Sirard & Pate, 2001; Welk et al., 2000a). In comparison, few studies (Hands et al., 2004; Le Masurier et al., 2005; Ng, 1999; Wilde et al., 2004) have examined the physical activity habits of high school students using objective measures.

One objective measure becoming more popular in physical activity research is pedometry. Pedometers are small digital devices typically worn on the waist which measures step counts as a result of vertical body displacement (e.g., hip acceleration). Pedometers provide an unobtrusive and inexpensive method for objectively assessing total physical activity in both research and health promotion settings. Depending on brand, pedometers have high accuracy in counting steps and provide a valid option for assessing physical activity among both children and adults (Eston et al., 1998; Kilanowski et al., 1999; Tudor-Locke et al., 2002b).

Since the conception of the pedometer, cut points for assessing pedometer-determined physical activity have emerged. The well-known criterion of 10,000 steps per day is frequently used in both public health promotion initiatives and by private health promotion organisations. For ostensibly healthy adults, 10,000 steps per day indicates an 'active lifestyle' (Tudor-Locke & Bassett, 2004), which roughly equates to the 30-minutes-per-day physical activity message (Le Masurier, Sidman, & Corbin, 2003; McCormack et al., 2006). Only recently have preliminary guidelines specific to the child population emerged. Body mass index (BMI) referenced standards for children aged six to 12 years suggest 15,000 steps per day for males and 12,000 steps per day for females (Tudor-Locke et al., 2004). Based on a descriptive study of 711 children aged six to 12 years old, Vincent and Pangrazi (2002b) recommended 11,000 steps per day for girls and 13,000 steps per day for boys. Although youth aged six to 17 years are recommended to accumulate at least 11,000 steps on at least five days per week as part of the Presidential Active Lifestyle Award (The President's Council on Physical Fitness and Sport, 2006), this

criterion is largely arbitrary. A health-based threshold for assessing step values specific to the adolescent population has yet to be established.

Average daily step-count values by sex and age are commonly reported in youth studies. Pedometer evidence consistently shows males are more active than females, with aggregated daily step counts ranging between 10,000 and 13,700 for males, and 8,400 and 11,300 for females (Hands et al., 2004; Le Masurier et al., 2005; Le Masurier & Corbin, 2006; Ng, 1999; Schofield et al., 2005b; Wilde et al., 2004). In addition, a trend towards reduced activity with age is typically observed (Corbin et al., 2004; Hands et al., 2004; Le Masurier et al., 2005), with steps counts peaking at age 12.8 years for females and 14.3 years for males (Hands et al., 2004).

Researchers, however, have yet to examine the number of young people meeting any step-based criteria. An obvious limitation of conducting such an examination is the absence of a criterion-based step threshold specific to the age range represented during the high school years. The 10,000-step threshold, which is reflective of being considered 'active' during adulthood (Tudor-Locke & Bassett, 2004), provides a conservative criterion for the youth population considering the commonly reported decline in physical activity during adolescence. For this reason, the present study examined the proportion of students achieving at least 10,000 steps per day.

In addition to determining overall activity, identifying key periods of low physical activity is crucial in directing future health promotion efforts. A convenient way to delineate these periods for youth is by dividing the week into school days (weekdays) and weekend days. Based on the limited evidence, some studies of high school students showed significantly higher activity counts (Klasson-Heggebo & Anderssen, 2003; Trost et al., 2000) and step counts (Rowe et al., 2004) on weekdays, whereas other studies showed lower step counts (significance not stated) on weekdays (Hands et al., 2004) or no significant differences between time periods when physical activity is assessed by heart-rate monitoring (Gavarry et al., 2003). The equivocal research findings in this area indicate further investigation is warranted.

Irrespective of time of week, youth can accumulate health-related physical activity within a number of contexts. One physical activity context receiving increased research attention is transport-related physical activity. Although increasing the prevalence of active transportation among young

people is recommended (US Department of Health and Human Services, 2001), especially walking to and from school, the importance of active transportation to daily physical activity levels of high school students has rarely been examined. A recent study found that students (aged 13 to 14 years old) who walked to and from school achieved 25.9 more minutes of moderate-to-vigorous physical activity (as assessed by accelerometers) than their peers who travelled by car, bus, or train to and from school (Alexander et al., 2005).

Although several studies have examined youth physical activity with objective measures (e.g., pedometers), several limitations with the methodology employed are apparent. First, previous research has included only those participants who had complete step data for a predefined number of days (typically a minimum of 4 days). Although this process is not a limitation for studies on children that typically report low exclusion levels, it might potentially bias the sample, and subsequently the results, of studies noting high exclusion levels (>30% exclusion level), which is apparent in studies of adolescents (Wilde et al., 2004). Second, although longitudinal data are usually collected, step-count data are frequently averaged before analysis, which substantially reduces the number of observations per participant to one and reduces the potential statistical power. Third, some previous statistical analyses have been applied to daily step-count averages in which the number of monitoring days may differ between participants, (e.g., some participants have complete step data for four days, while other participants have complete data for five days or six days). The common statistical analyses applied to these averages will not account for within-subject variation or differences in variance of step counts when the number of monitoring days varies between participants. To address the above mentioned limitations, the data in our study has been analyzed using generalizing estimating equations (GEE).

The aims of the current study therefore were twofold. Firstly, to examine daily step-count levels according to age, sex, time of week, and transportation mode. Secondly, to determine the percentage of youth who meet the 10,000-steps-per-day criterion by sex and age.

Methods

This study is linked with a larger study known as the Obesity Prevention in Communities (OPIC) project, an ecological-based obesity prevention initiative

focusing on high school students that is being conducted across four countries (Australia, New Zealand, Fiji, and Tonga). In New Zealand, the intervention is targeting youth attending schools with a low socioeconomic rating within a predefined suburb in South Auckland, New Zealand. To reduce school burden, three of the intervention schools were approached to participate in this pedometer study.

Sample

Data were collected from a convenience sample of students attending one of three high schools within Manukau City, Auckland. All schools were of low socioeconomic status with a decile rating of one or two. The decile rating is a proxy for socioeconomic status ranging from one (most deprived) to 10 (least deprived). From the three schools, 20 classes in total were approached to participate in this study, with the number of classes approached per school relative to the number of students attending each school. A total of 348 students agreed to participate.

Only participants aged 12 to 18 years old were included for analysis. Through using GEE analysis, which is a standard statistical method often used in situations in which there is missing longitudinal data (Twisk, 2003), all participants who had a least one weekday of pedometer data were considered for inclusion in the analysis. The inclusion of data with only one or two data points overcomes the potential sample bias if such data were excluded. All step values collected on days with reported compliance (i.e., not detaching the pedometer for more than one-waking hour per day) were included. Dealing with outliers among the youth population has received little attention. In line with a recent study on children (Rowe et al., 2004), daily step counts between 1,000 and 30,000 were included.

For the GEE analysis, participants were excluded if they (1) were outside the age criteria ($n = 4$, 1.1%), (2) had provided no age data ($n = 9$, 2.6%), (3) had no weekday data ($n = 4$, 1.1%), (4) had no pedometer data ($n = 51$, 14.7%), (5) did not comply with pedometer instructions ($n = 37$, 10.6%), or (6) had all their pedometer data points below 1,000 steps or greater than 30,000 steps ($n = 7$, 2.0%). In total, 112 participants (32.2%) were excluded leaving a final sample of 236 participants with 844 usable data points. The exclusion of 32% of the participants is similar to another pedometer-based study of high school

students that used more stringent inclusion criteria and reported an exclusion percentage of 39% (Wilde et al., 2004). Chi-square analysis revealed no significant sex or age group differences between the included and excluded participants.

Of the 236 participants (mean age = 15.3 ± 1.6 years), female (59.7%) and junior (Year 9, 10 & 11 students, 58.5%) students composed a larger proportion of the sample compared than did their male and senior (Year 12 & 13 students) peers, respectively. Ethical approval was gained from the Auckland University of Technology Ethics Committee (Appendix A). Informed consent to participate was obtained from the Principal of each school, all participants, and parents for students aged below 16 years of age. Copies of the consent forms and information sheets are provided in Appendices B to G.

Measures

Pedometer The NL-2000 pedometer (New-Lifestyles Inc.) was used as it displays high accuracy (within $\pm 3\%$ of actual step taken) and intra-model reliability (Crouter et al., 2005; Schneider et al., 2003), and has memory capacity to store seven consecutive days of data. A check of functionality and reliability of each pedometer was conducted prior to the start of the study with a step-count test. All pedometers were found to be within the acceptable $\pm 3\%$ margin of error. Before the reuse of each pedometer, the pedometer's clock was checked to ensure the one-day epoch covered the 24-hour time period from midnight to midnight.

Questionnaire Mode of transport to and from school was collected by questionnaire. Participants were asked to indicate how they travelled to and from school over each of the previous three school days from one of four response options (car, bus, walk, and bike). For analysis purposes, students were categorised into one of five groups: 'car only' – travelled to and from school by car, 'bus one way' - travelled by bus to or from school but did not walk, 'bus only' - traveled to and from school by bus, 'walk one way' - travelled to or from school by walking, and 'walk only' - travelled to *and* from school by walking. A copy of the questionnaire is provided in Appendix H.

Data Collection

Data were collected during the Southern hemisphere spring season (between late August and early November) in 2005. Before data collection, all students were informed about the study, and the required consent forms and information sheets were distributed to each participant and collected once completed. On the first monitoring day, participants received a sealed pedometer and instructions regarding pedometer attachment. Participants were asked to wear the pedometer from the time they woke up in the morning until bedtime the same day, every day for seven days. Only during water-based activities (e.g., swimming, showering) and competition contact sport were the participants instructed to detach and reattach their pedometer directly before and after the precluded activity. On the final monitoring day, participants returned their pedometer and completed a short questionnaire (to gain information on their main mode of transportation to and from school) and a compliance form (requesting information on the number of hours they did not wear the pedometer on each of the previous five days). Noncompliance with the pedometer instructions was operationalised as individuals detaching the pedometer for more than one hour during their wake time, a protocol used in prior studies (Wilde et al., 2004). Data collected on monitoring days two through six were included in the analyses as pedometer distribution and collection took place on monitoring days one and seven; these days, therefore, did not represent complete data. As a result, five full days of complete pedometer data could be potentially collected per participant.

Data Analysis

The data were analysed using the GEE procedure with repeated measures and an unstructured correlation matrix. Generalizing estimating equations was chosen because (1) the variation in step counts for each potential collection period (one to five days) is taken into account, thereby allowing inclusion of participants who wore the pedometer for a minimum of one day and, in turn, maximising participant retention and sample size; (2) it maximises statistical power of the study design by analysing all data points rather than averaged step counts; and (3) it takes into consideration the covariance structure of the repeated data points, which are likely to be correlated.

Data were analysed using Statistical Analysis System (SAS) version 9.1 (SAS Institute Inc., Cary, NC, USA), with corrections for any design effects arising from the sampling method employed. Through the GENMOD procedure in SAS, GEE estimated daily step counts and standard errors according to age group, sex, time of week, and engagement levels in active transportation with respective p-values. For each GEE model, all potential main effects (age, sex, time of week) as well as all possible two-way and three-way interactions were initially entered into the model and examined for significance. Using a stepwise process, only those interactions and main effects that were significant ($p < 0.05$) were included in the final GEE model.

When determining the proportion of days on which students reached 10,000 steps, only those students with at least three days of pedometer data were included for the analysis ($n=193$). The following method was used to determine the percentage of days on which each student achieved the 10,000-step criterion: (the number of days meeting the recommended guidelines/total number of usable days monitored) * 100. Each participant was then categorised into one of four groups: 'never' (did not achieve 10,000 steps on any day they have complete data), 'sometimes' (achieved 10,000 steps at least once but on less than half of the days they had complete data), 'often' (achieved 10,000 steps on at least half (but not all) of the days they had complete data), and 'always' (achieved 10,000 steps on all days they had complete data).

The reasons for choosing the 10,000-step threshold are as follows. First, in a population in which physical activity substantially declines during the high school years, the 10,000-steps-per-day-threshold, which is reflective of being active for adults, can be considered a conservative level that most young people should try to achieve. Second, 10,000 steps per day provides a middle ground between step thresholds (7,500-9,999 steps per day) that indicate an adult to be somewhat active (Tudor-Locke & Bassett, 2004) and preliminary recommended step thresholds (12,000 to 15,000 steps per day) for children (Tudor-Locke et al., 2004). Third, although determining the proportion of students achieving this criterion does not represent the percentage considered active, nor does it correspond to a magic number in which health benefits appear for any population group, it does provide a benchmark to monitor physical activity trends of high school students. Future research, however, needs to establish best practice step thresholds for the adolescent population

that are based on a health criterion and that are in line with recent time-based guidelines (Strong et al., 2005).

Results

Daily Step Counts

Table 12 shows the results from the GEE analyses used to estimate daily step counts while adjusting for clustering by school. Daily step counts differed by sex, age group, and time of week. After adjusting for all factors, that males accumulated nearly 1,100 more daily steps than their female peers, junior students accrued over 1,600 more steps daily than their senior peers, and higher daily step counts were achieved on weekdays than weekend days. In addition, a significant age-group by time-of-week interaction emerged. A larger reduction in step counts from weekdays to weekend days was observed for the junior school students compared to their senior counterparts. Although there was a significant step-count differential existed between age groups on weekdays, this was not the case for weekend activity.

Table 12: Estimated Daily Step Counts (\pm Standard Error) According to Sex, Age Group, and Time of Week, Adjusted for Each Other.

Variable	Estimated Daily Steps \pm SE ^a	p-value
Sex		
Female	9,652 \pm 289	0.01
Male	10,849 \pm 381	
Age Group		
Junior	11,079 \pm 330	0.0004
Senior	9,422 \pm 334	
Time of week		
Weekday	12,259 \pm 287	<0.0001
Weekend	8,241 \pm 329	
Time of week by age group		
Weekday Junior	13,575 \pm 401	0.01
Weekend Junior	8,583 \pm 420	
Weekday Senior	10,944 \pm 374	
Weekend Senior	7,900 \pm 470	

^aSE corrected for cluster effect by school

Engagement in Active Transportation

From the sample of 236 participants, 230 had completed questions on transportation to and from school and were, therefore, included for analysis. Daily step counts were limited to the school days only. Results from the GEE

procedure examining daily step counts by level of engagement in active transportation to and from school on weekdays are shown in Table 13. After adjusting for age, sex, and the school effect, the final GEE model revealed significant differences in accrued steps between those using different transportation modes ($p=0.006$). Compared to the car-only reference group, the walk-only group accumulated over 2,300 more steps and the walk-one-way group accrued over 1,700 extra steps daily.

Table 13: Estimated Weekday Daily Step Counts (\pm standard error) According to Mode of Transportation and Adjusted by Age and Sex

Mode of Travel	Estimated Daily Steps \pm SE ^a	p-value
Car only	10,986 \pm 435	Referent
Bus one way	12,462 \pm 825	0.08
Bus only	12,397 \pm 675	0.06
Walk one way	12,741 \pm 453	0.002
Walk only	13,308 \pm 483	0.0002

^aSE corrected for cluster effect by school

The proportion of students using the different modes of transportation by school is presented in Table 14. Substantial differences in transportation patterns between the three participating schools are apparent. Most students in School 2 (56.7%) walked to and from school, whereas a smaller proportion of students undertook this behaviour at School 1 (38.9%). Only 7% of students at School 3 travelled to and from school by car.

Table 14: Percentage of Students Participating in Each Transport Mode by School

Mode of Travel	Total (%)	School 1 (%)	School 2 (%)	School 3 (%)
Car only	34.1	30.7	14.9	67.3
Bus one way	4.3	3.6	2.8	8.0
Bus only	4.5	4.0	3.6	7.1
Walk one way	20.1	22.8	22.0	10.6
Walk only	37.0	38.9	56.7	7.0

Achievement of the 10,000 Steps per Day Criterion

Of the 236 participants, 193 had at least three days of pedometer data and were, therefore, included in this analysis. As shown in Table 15, participants were categorised into one of four groups depending on the percentage of total days monitored on which they achieved the 10,000-step criterion. Few students met the 10,000-step criterion on each day for which they had complete data (i.e., the always group), although a substantial proportion (49.7%) did achieve 10,000 steps on at least half (but not all) of the days for which they had complete data. Depending on the participants sex and age, between 7.0% and 14.1% of students never met the 10,000-steps-per-day criterion.

Table 15: Percentage of Students Who Meet the 10,000-Step Criterion

	Never ^a (%)	Sometimes ^b (%)	Often ^c (%)	Always ^d (%)
Total	11.4	24.4	49.7	14.5
Sex				
Female	13.9	27.0	49.2	9.8
Male	7.0	19.7	50.7	22.5
Age Group				
Junior	9.6	15.7	54.8	20.0
Senior	14.1	37.2	42.3	6.4

^a Did not achieve 10,000 steps on any day for which they had complete data

^b Achieved at least 10,000 steps at least once but on less than half of the days for which they had complete data

^c Achieved at least 10,000 steps on at least half of the days but not on every day for which they had complete data

^d Achieved at least 10,000 steps on all days for which they had complete data

Discussion

Three key findings which were congruent with prior studies emerged. First, total step counts were comparable to those of earlier pedometer-based studies on youth (Hands et al., 2004; Le Masurier et al., 2005; Le Masurier & Corbin, 2006; Ng, 1999; Wilde et al., 2004); however, the daily steps observed among New Zealand youth fall in the lower end of the step-count spectrum, indicating that youth in this study may be less active than many of their non-New Zealand peers. Second, in support of research showing a sex difference in physical activity, higher physical activity levels were observed in males than females. Third, a drop in step counts by age group was observed, with junior students accumulating 1,657 more steps per day compared to their senior

counterparts. In addition, the accumulated steps were substantially lower than the mean weekdays (boys; 16,133 ± 3,864; girls, 14,124 ± 3,286) and weekend (boys, 12,702 ± 5,048; girls, 11,158 ± 4,309) step counts reported in a large sample of New Zealand primary school students (Duncan et al., 2006).

In support of findings reported by Trost et al (2000) and Klasson-Heggebo et al (2003), our data also demonstrates lower physical activity levels on weekend days than on weekdays. Developing out-of-school strategies, therefore, might maximise potential gain in physical activity health promotion for all age groups. This, however, does not preclude the importance of school-day physical activity strategies, especially for senior students who demonstrate significantly lower levels on school days compared to their junior peers. A possible contributor to the school-day differential in daily step counts is participation in physical education class. Although physical education is available at each high school year level, physical education is a compulsory subject only for students in Years 9 and 10, which in turn may have contributed to the higher step counts noticed among this junior age group. Furthermore, strategies targeting habitual activity on school days might be more easily implemented than those targeted at weekend physical activity.

Promoting active transportation as a school-related strategy is further supported by our study, as students walking to and/or from school accrued significantly greater steps than car transit users, a finding reported by previous research using accelerometers (Alexander et al., 2005). The proportion of students walking to school differed substantially between schools. Because School 3 is an integrated Christian school, students are likely to travel from beyond the local school area to attend. This might explain, in part, the substantially higher car user level (and lower level of walking) of students at School 3. Strategies targeting active transportation, therefore, may be a key strategy for some but not all schools, which highlights the need for school-specific strategy development.

A main finding of this study was the proportion of students meeting the 10,000- steps-per-day criterion. Few students, especially female and senior students achieved 10,000 steps on all days for which each student had available data. Considering the substantial decline in physical activity during adolescence, it is likely that the current youth population will fail to reach the 10,000-step criterion as they enter young adulthood. Although other studies,

through the use of accelerometers or questionnaires, have examined the proportion of young people considered active (i.e., achieving time-based guidelines) (Pate et al., 2002; Riddoch et al., 2004; Sport and Recreation New Zealand, 2003), making direct comparisons with the findings noted in this article is difficult for two reasons. First, the 10,000-step criterion is not specific to youth, and may not correctly classify a teenager as active or not. Second, previous research on both adult- and child-population groups has found difficulty in defining a step threshold that accurately identifies those who meet currently recommended time-based physical activity guidelines (Rowlands & Eston, 2005; Tudor-Locke, Ainsworth, Thompson, & Matthews, 2002a; Welk et al., 2000b). The aim of this study, therefore, was not to examine the proportion of students deemed active, but rather the proportion reaching 10,000 steps daily, a conservative criterion that should be achieved by young people considering the continuous subsidence of physical activity during the adolescent years.

The findings of the current study must be viewed in light of the following limitations. Although pedometers provide an objective tool to measure physical activity, thereby overcoming the subjective limitations inherent in self-report methods, pedometers are not designed to measure intensity of activity or nonambulatory (e.g., swimming) or isometric physical activities. One consequence, therefore, is that we are unable to examine the percentage of students meeting the current moderate-to-vigorous physical activity recommendations (Strong et al., 2005). Duration and intensity of physical activity participation can be captured through use of accelerometry; however, pedometers provide a less expensive and, therefore, more plausible alternative for gathering objective physical activity data among youth. An advantage of the NL-2000 pedometer (New-Lifestyles Inc.) used in this study is that it has an internal clock and data storage capacity to store total step counts at one-day epoch intervals for a total of seven days. The pedometer could not, however, provide smaller epoch intervals, which limits the ability to capture step counts during certain segments of the day without increasing participant or researcher burden.

As the larger OPIC project purposefully recruited students of low socioeconomic status, the resultant sample for this study (because of size and convenience sampling from the OPIC school sample) is not representative of

the New Zealand youth population. In comparison to the high school population of New Zealand, a slightly higher proportion of the sample in this study was female (50% versus 58.5%, respectively). Although ethnicity was not collected from participants, the schools included in this study have a large proportion of Māori and Pacific Island students, two key groups the OPIC project is targeting. At each school, between 67% and 92% of students identified being Māori or of Pacific descent, whereas the ethnic composition for the New Zealand child population (<15 years old) is 7.6% Pacific Island, 24.5% Māori, 62.4% European, and 5.0% Asian. Although convenience sampling is not the gold standard, the sample size and sampling methods employed in this study are in line with published studies assessing children (Flohr, Todd, & Tudor-Locke, 2006; Tudor-Locke et al., 2006; Vincent & Pangrazi, 2002b) and youth (Le Masurier & Corbin, 2006; Wilde et al., 2004) physical activity using pedometers. While the generalisability of the findings to the New Zealand youth is limited, and that the findings need to be confirmed using a larger representative sample, they are the first published New Zealand pedometer data that are inclusive of all age groups represented at high school.

Another limitation is that a large proportion of participants (32.2%) and data points (51.2%) were excluded from the final GEE analysis. Several reasons are likely for the loss of participants and data. While the use of pedometers that have a memory capacity reduces participant and researcher burden of recording daily step counts, the prompt to wear the pedometer that daily recording provides is lost. In addition, conducting research within a high school environment is substantially different to that of a primary school situation. In primary school, students generally have the same teacher each day, which standardises pedometer distribution and allows the teacher to provide consistent reminders to wear the pedometer daily. This, however, is not always possible within the high school setting.

Also, it has been suggested that seven days of monitoring is associated with a reliable estimate of physical activity among adolescents using accelerometers (Troost, 2001). This length of monitoring may not always be practical or attainable and may not be directly transferable as an accurate monitoring frame for assessing physical activity using pedometry. Because of compliance issues with this population group, the GEE-analysis approach was used to maximise the sample size while accounting for the variation in the

number of complete data-collection days obtained between participants, which allowed participants with at least one weekday of data to be included for analysis. As a result, any potential bias that may have occurred due to analysing only participants with complete data was minimised. When examining the proportion of students achieving the 10,000-step criterion, only those with a minimum of three days of data were included for the analysis. While this monitoring frame may not represent habitual physical activity, it is similar to those used in previous research (Ng, 1999; Wilde et al., 2004).

In summary, the current study is the first published study to provide insight into objectively determined physical activity levels and subjectively examined transportation patterns of high school students in New Zealand. Although a large proportion of students do not achieve at least 10,000 steps daily, increasing the level of students engaging in active transportation, a habitual activity that could be incorporated into the daily routine of students, could assist students to achieve part of their daily activity dose. Strategies implemented, however, need to meet the needs of students at specific schools because, at least in this study, substantial differences in active commuting patterns were noticed between schools. Future exploration of objectively determined activity behaviours using a larger sample size is needed, as well as examination of potential correlates of activity among New Zealand high school students. Also, considering the substantially lower levels of physical activity on weekend days, examination of competing sedentary behaviours should be investigated.

Chapter 7: Self-Reported Physical Activity Levels during a Segmented School Day

Preface

The data presented in the previous chapter described daily step count levels among a sample of high school students in New Zealand. The data highlighted activity trends similar to that noted in international literature. Adding to international literature, few participants achieved the 10,000 steps per day threshold (which often denotes an active lifestyle for adults). Due to the subsidence in activity during adolescence, these future adults are unlikely to reach 10,000 steps per day during adulthood. These findings highlighted public health urgency for interventions that have improved youth physical activity as the key outcome.

Whilst useful, pedometer data only provides a reflection of volume of activity. The lack of precise information about when and where young people are physically active (or inactive) precludes its ability to identify key physical activity contexts in which large gains in activity levels could be achieved. Such information could inform the direction of future interventions and potentially maximise the cost-benefit outcomes from the resources invested.

Even though young people were found to be more active on weekdays than weekend days, understanding school day activity is of importance. On school days, schools provide an ideal environment where intervention effort could be directed. First, the majority of the youth population is reachable through the school system. Second, interventions are potentially more easily implemented on school days compared to weekend days. Third, school-based interventions are particularly important for adolescents who are not likely to be active outside of the school environment. Lastly, as seen with primary and intermediate aged children, the school day consists of several salient opportunistic time periods (before, during, and after school through sport, cultural activities, play, and active transportation) during which young people have been shown to achieve part of their required daily physical activity dose.

Whilst international literature about active transportation exists; less is known about recess and after school activity. Again, New Zealand-specific data during such time periods is nonexistent for all ages represented at high school. In addition to these reasons, the foci of the OPIC intervention (as determined by

key stakeholders) were increased active commuting and lunchtime activity. The objectives of this chapter were to describe high school students' physical activity patterns during lunchtime, morning recess, after-school through sport, cultural activities, and before and after school through active transportation. Expanding international literature, which typically reports prevalence on individual contexts, domains, or location-specific activities, physical activity across all time periods was measured among a large ethnically diverse sample (n=3,451). Consequently, the question 'are young people utilising all opportunities to be active?' can be answered. In turn, time periods of low activity can be potentially highlighted and identified as periods which could provide greater return on investment if targeted in future interventions.

Introduction

Physical activity is well recognised as a health-promoting behaviour for adolescents (Strong et al., 2005). Many young people, however, do not engage in sufficient levels to afford the associated health benefits (Centers for Disease Control and Prevention, 2006a; Sport and Recreation New Zealand, 2003). Young people from low socioeconomic status (SES) groups are at particular risk of low physical activity levels (Inchley et al., 2005; Raudsepp, 2006) and participation in organised activities (La Torre et al., 2006; Santos et al., 2004).

For youth, the school day provides multiple opportunistic time periods (e.g., before school, morning recess, lunchtime, after school) to accumulate their daily activity dose (Alexander et al., 2005; Ridgers et al., 2005; Tudor-Locke et al., 2006) through informal play, sport, and active commuting. Internationally, substantial data on active transportation exist (Martin & Carlson, 2005; US Department of Transportation, 1972). Much less, however, is known about physical activity behaviours during the after-school period (Schofield et al., 2002; Tudor-Locke et al., 2003a), which is considered a 'critical window' for young people to accumulate necessary health-related physical activity, or during recess/lunchtime breaks (Hands et al., 2004; Tudor-Locke et al., 2006). In New Zealand, irrespective of time period or context, the evidence is sparse (Land Transport and Safety Authority, 2000; Parnell et al., 2003) and in some instances nonexistent for the high school population. Examination of youth activity during the various segments of a school day is, therefore, warranted for several reasons: to gain insight into youth activity levels during various opportunistic time periods, to determine if youth are maximising multiple time periods to be active, and to identify priority time periods that should be considered in future interventions.

This research extends previous work by describing high school students' physical activity across four time-specific physical activity opportunities that are available within a normal school day using a large multiethnic and low socioeconomic sample. The proportion of young people deemed active (and less active) for each physical activity opportunity, and whether young people are active across all four opportune time periods were determined. Associated demographic and anthropometric variables were also investigated.

Methods

Data Collection

The OPIC (Obesity Prevention In Communities) project, which is being conducted across four countries (Australia, New Zealand, Fiji, and Tonga), is an obesity prevention initiative targeting high school aged students in a predetermined suburb/neighbourhood in each country. The measures and data presented in this paper represent a portion of the variables and data collected from schools participating in the New Zealand arm of the OPIC project. Ethics approval for the project was gained from the University of Auckland Ethics Committee (Appendix Q). Consent was gained from all students, parents of students aged below 16 years, and the Principal of each participating school. Copies of the consent forms and information sheets are provided in Appendices R to W.

Sample

Students were recruited from seven low SES (decile rating of 1 or 2) high schools located in South Auckland, New Zealand. The decile rating, which ranges from 1 (most deprived) to 10 (least deprived), indicates the extent to which the school draws its students from low socioeconomic communities. Based on school enrolment numbers, the response rate varied by school, and ranged from 25% up to 78% (school average = 58%). For all schools combined, the original sample surveyed in 2005 was 3,581 (response rate of 53% from 6,827). Of this total, 14 participants (0.4%) were excluded due to not meeting age criteria for inclusion (i.e., 12-18 years old, inclusively) and a further 96 participants (2.7%) were excluded as a result of incomplete data. Therefore, the final sample consisted of 3,471 participants (97% of the original sample surveyed) with a mean age of 14.8 ± 1.4 years, and a composition of 48% male, 72% junior students (Years 9-11) and a mix of different ethnicities (Pacific Island descent, 57%; Māori, 20%; European, 12%; Asian/Other, 11%).

Measures

Physical Activity Variables The questionnaire comprised four questions that assessed levels of active transportation, activity during lunchtime, activity during morning recess, and activity during the after-

school time period. These items were directly replicated from the national New Zealand Children's Nutrition Survey (Parnell et al., 2003), which was based on the Physical Activity Questionnaire for Children (PAQ-C). The PAQ-C has demonstrated acceptable reliability and validity when compared to various questionnaires and the Caltrac motion sensor (Crocker et al., 1997; Kowalski et al., 1997a). Face and content validity of each Children's Nutrition Survey question was undertaken by the authors, and participant comprehension was tested during the piloting of the entire OPIC survey. A full copy of the OPIC questionnaire is presented in Appendix X.

For lunchtime and morning recess activity participants were asked "over the last five school days, what did you do most of the time at [*morning recess /lunchtime*] (apart from eating)" and requested to choose one of three response options. Based on their response, participants were dichotomised into "more active" (i.e., mostly played active games) or "less active" (i.e., mostly just sat down or mostly stood or walked around) groups. To assess after-school physical activity participants were asked to self-report the number of days (0 to 5 days) over the previous five school days they participated after school in sports, dance, or cultural performances, or played games in which they were active. Participants were then dichotomised into 'more active' (i.e., \geq three school days) or 'less active' (i.e., \leq two days) groups. For active transportation, each participant reported the number of trips he/she made by biking or walking to or from school over the previous five school days. Participants were dichotomised into 'more active' (i.e., at least five trips) or 'less active' (i.e., fewer than five trips) groups.

Anthropometric Measures Using an electronic scale (BC418 Body Composition Analyzer, Tanita, UK), each participant's weight was measured to the nearest 0.1kg whilst height (without shoes on) was measured to the nearest 0.1cm with a standard portable stadiometer. Based on international age and sex-specific BMI cut-off points (Cole, Bellizzi, Flegal, & Dietz, 2000), participants were classified as either obese, overweight, or nonoverweight/obese. Waist circumference (to the nearest 0.1cm) was measured three times at the level of the umbilicus at minimal respiration using the Figure Finder (Novel Products Inc, Rockton, IL, USA) anthropometric tape. The median waist value constituted the participant's

final waist measurement. Participants were then classified into one of four groups based on their waist circumference relative to the entire sample; average central adiposity (<60th percentile for age and sex), moderate central adiposity (60th to 80th percentile for age and sex), high risk central adiposity (80th to 90th percentile for age and sex), and very high central adiposity ($\geq 90^{\text{th}}$ percentile for age and sex). Although no internationally accepted waist circumference classification system exists for the youth population, the percentile cut-points in the current study were guided by those proposed for Caucasian New Zealand children and adolescents (Taylor, Jones, Williams, & Goulding, 2000).

Data Analysis

Data were analysed using Statistical Analysis System (SAS) version 9.1 (SAS Institute Inc., Cary, NC, USA). Using binary logistic regression for complex surveys, participants were categorised as either 'more active' or 'less active' for each physical activity variable. Both crude and adjusted odds ratios (ORs) and 95% confidence intervals (95%CI) were corrected for the cluster effects arising from sampling students by class. Factors included in the final multivariate model for each physical activity variable were determined using a stepwise process. All variables were included in the initial model, and excluded if found to be non-significant ($p > 0.05$). Within each model the reference group for each demographic variable was junior students, females, Māori, non-overweight/obese, and average central adiposity.

Results

Engagement across Individual Physical Activity Opportunities

Similar to levels of active transportation, just over half of the students were deemed 'more active' during the after-school time period (as part of sports, dance, cultural performances, or active games), which decreased to less than one-third during morning recess and lunchtime (Table 16). Crude ORs and respective CIs for each demographic variable were determined (Table 17). To identify the demographic variable(s) that exerted the greatest effect on participation, adjusted ORs (AOR) were examined (Table 18). Based on the AORs males were at least three times more likely to be categorised as 'more active' during lunchtime and morning recess, and at least 30% more likely as

part of after-school physical activity and active transportation than females. Junior students were at least 27% more likely to be categorised as 'more active' during lunchtime, morning recess, and active transportation. Compared to Māori students, Pacific Island students were more likely to be deemed 'more active' during lunchtime and in after-school activities; students of Asian/Other descent were less likely to be in the 'more active' group across all physical activity variables, and European students were less likely to be in the 'more active' group for all physical activity variables (except active transportation). While overweight and obese students were at least 27% more likely to be in the 'more active' group during morning recess compared to their non-overweight/obese peers, individuals at very high risk of central adiposity were less likely to be in the 'more active' group during lunchtime and morning recess with significant ORs in the range of 0.51 - 0.69.

Table 16: Percentage of Participants Categorised as 'More Active' Across Four Physical Activity Opportunities

Variable	n	Physical Activity Opportunities				More active across ≥3 physical activity opportunities ^d (%)
		More active ^a at lunchtime (%)	More active ^a at morning recess (%)	More active ^b after school (%)	More active ^c commuting (%)	
Total	3,471	32.4	26.4	56.3	58.1	
Sex						
Male	1,651	46.2	39.6	60.4	61.5	37.9
Female	1,820	19.9	14.3	52.6	55.1	15.2
Age Group						
Junior	2,490	34.9	29.4	57.2	60.0	28.7
Senior	981	26.1	18.8	54.1	53.4	19.1
Ethnicity						
Pacific Island	1,986	37.6	29.8	62.1	58.8	30.6
Asian/Other	370	25.4	20.5	41.9	46.2	16.5
European	408	19.1	15.0	43.4	57.6	14.5
Māori	707	29.4	26.4	55.0	62.8	24.6
BMI status^d						
Obese	921	32.8	28.6	58.3	56.9	27.7
Overweight	1,094	33.4	27.5	60.1	58.8	26.5
Non obese/overweight	1,456	31.5	24.1	52.2	58.4	24.5
Central adiposity^e						
Very High	356	29.5	24.4	57.9	53.1	23.6
High	349	34.1	30.4	59.0	59.3	29.2
Moderate	693	31.7	26.0	58.7	58.7	25.2
Average	2,072	32.9	26.1	54.8	58.6	26.1

^a Played active games most of the time

^b Participated in sport, dance, cultural performances, or played active games after school on at least 3 weekdays

^c Walked/biked to or from school for at least 5 trips

^d BMI status based on BMI cut points developed by Cole et al (2000)

^e Central adiposity based on percentile cut points for age and sex within this sample (<60th, 60th - 80th, 80th - 90th and ≥90th percentile for age and sex)

Table 17: Crude Odds Ratios of Being Categorised as ‘More Active’ Across Four Physical Activity Opportunities by a Selection of Demographic Variables

Variable	Physical Activity Opportunities								More active across ≥ 3 physical activity opportunities ^d	
	More active ^a at lunchtime		More active ^a at morning recess		More active ^b after school		More active ^c commuting		OR (95%CI) ^e	p-value
	OR (95%CI) ^e	p-value	OR (95%CI) ^e	p-value	OR (95%CI) ^e	p-value	OR (95%CI) ^e	p-value		
Sex		<0.0001		<0.0001		<0.0001		0.0002		<0.0001
Male	3.45 (2.89-4.12)		3.92 (3.16-4.85)		1.37 (1.19-1.58)		1.30 (1.14-1.50)		3.39 (2.79-4.12)	
Female	1.0				1.0		1.0		1.0	
Age group		0.002		<0.0001		0.19		0.02		0.0001
Junior	1.52 (1.17-1.98)		1.80 (1.36-2.38)		1.13 (0.94-1.36)		1.31 (1.05-1.62)		1.71 (1.30-2.25)	
Senior	1.0		1.0		1.0		1.0		1.0	
Ethnicity		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001
Pacific Island	1.44 (1.16-1.80)		1.18 (0.93-1.50)		1.34 (1.08-1.67)		0.84 (0.67-1.06)		1.35 (1.06-1.72)	
Asian/Other	0.82 (0.59-1.13)		0.72 (0.53-0.98)		0.59 (0.44-0.79)		0.51 (0.38-0.68)		0.61 (0.43-0.86)	
European	0.57 (0.40-0.80)		0.49 (0.35-0.69)		0.63 (0.47-0.84)		0.81 (0.59-1.10)		0.52 (0.36-0.74)	
Māori	1.0		1.0		1.0		1.0		1.0	
BMI status^f		0.63		0.03		<0.0001		0.67		0.22
Obese (ob)	1.06 (0.89-1.27)		1.26 (1.06-1.50)		1.28 (1.08-1.52)		0.94 (0.79-1.12)		1.18 (0.98-1.42)	
Overweight (ow)	1.09 (0.91-1.30)		1.20 (1.00-1.43)		1.38 (1.19-1.60)		1.02 (0.87-1.81)		1.11 (0.92-1.34)	
Non ob/ow	1.0		1.0		1.0		1.0		1.0	
Central adiposity^g		0.52		0.43		0.15		0.27		0.48
Very High	0.85 (0.67-1.08)		0.92 (0.70-1.20)		1.13 (0.90-1.42)		0.80 (0.63-1.02)		0.87 (0.67-1.15)	
High	1.06 (0.82-1.36)		1.23 (0.94-1.62)		1.19 (0.92-1.53)		1.03 (0.81-1.32)		1.17 (0.89-1.53)	
Moderate	0.95 (0.79-1.13)		0.99 (0.82-1.20)		1.18 (1.00-1.38)		1.01 (0.84-1.20)		0.96 (0.79-1.16)	
Average	1.0		1.0		1.0		1.0		1.0	

^a Played active games most of the time

^b Participated in sport, dance, cultural performances, or played active games after school on at least 3 weekdays

^c Walked/biked to or from school for at least 5 trips

^d Classified as active in a minimum of three time-specific activity opportunities (i.e., after school physical activity, active transportation, lunchtime physical activity, morning recess physical activity)

^e Adjusted for the effect of school clustering

^f BMI status based on BMI cut points developed by Cole et al (2000)

^g Central adiposity based on percentile cut points for age and sex within this sample (<60th, 60th - 80th, 80th - 90th and ≥90th percentiles)

Nb: nonsignificant variables were excluded from the final multivariate model

Table 18: Adjusted Odds Ratios of Being Categorised as ‘More Active’ Across Four Physical Activity Opportunities by a Selection of Demographic Variables

Variable	Physical Activity Opportunities								More active across ≥ 3 physical activity opportunities ^d	
	More active ^a at lunchtime		More active ^a at morning recess		More active ^b after school		More active ^c commuting		OR (95%CI) ^d	p-value
	OR (95%CI) ^e	p-value	OR (95%CI) ^e	p-value	OR (95%CI) ^e	p-value	OR (95%CI) ^e	p-value		
Sex		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001
Male	3.50 (2.91-4.20)		4.0 (3.23-4.98)		1.38 (1.20-1.59)		1.32 (1.15-1.50)		3.44 (2.82-4.20)	
Female	1.0		1.0		1.0		1.0		1.0	
Age group		0.003		<0.0001				0.03		0.0002
Junior	1.50 (1.15-1.96)		1.78 (1.33-2.38)				1.27 (1.02-1.58)		1.68 (1.28-2.21)	
Senior	1.0		1.0				1.0		1.0	
Ethnicity		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001
Pacific Island	1.47 (1.15-1.87)		1.12 (0.86-1.46)		1.32 (1.06-1.65)		0.84 (0.68-1.05)		1.33 (1.03-1.71)	
Asian/Other	0.72 (0.52-0.99)		0.67 (0.49-0.91)		0.57 (0.43-0.76)		0.51 (0.38-0.68)		0.55 (0.39-0.78)	
European	0.53 (0.37-0.76)		0.47 (0.33-0.68)		0.62 (0.46-0.84)		0.81 (0.59-1.10)		0.50 (0.35-0.72)	
Māori	1.0		1.0		1.0		1.0		1.0	
BMI status^f				0.02						
Obese (ob)			1.67 (1.15-2.42)							
Overweight (ow)			1.27 (1.01-1.59)							
Non ob/ow			1.0							
Central adiposity^g		0.02		0.02						
Very High	0.69 (0.53-0.89)		0.51 (0.32-0.81)							
High	0.93 (0.71-1.23)		0.78 (0.51-1.20)							
Moderate	0.83 (0.68-1.02)		0.72 (0.55-0.95)							
Average	1.0		1.0							

^a Played active games most of the time

^b Participated in sport, dance, cultural performances, or played active games after school on at least 3 weekdays

^c Walked/biked to or from school for at least 5 trips

^d Classified as active in a minimum of three time-specific activity opportunities (i.e., after school physical activity, active transportation, lunchtime physical activity, morning recess physical activity)

^e Adjusted for the effect of school clustering and all other variables included in each model

^f BMI status based on BMI cut points developed by Cole et al (2000)

^g Central adiposity based on percentile cut points for age and sex within this sample (<60th, 60th - 80th, 80th - 90th and ≥90th percentile)

Nb: nonsignificant variables were excluded from the final multivariate model

Engagement across Multiple Physical Activity Opportunities

Of the four physical activity opportunities examined, the percentages of participants in the 'more active' group for one, two, three, or across all four time periods were 31%, 27%, 15%, and 11% respectively. Seventeen percent of students were not in the 'more active' group for any time period examined. Adjusted ORs presented in Table 18 indicate that males were over three times more likely than females, and junior students were 1.68 times more likely than senior students to be in the 'more active' group across at least three physical activity opportunities versus the referent group of two or less opportunities. Compared to Māori students, Asian/Other and European students were less likely, and Pacific Island youth were more likely, to be in the 'more active' category across at least three physical activity opportunities.

Level of Agreement between Various Physical Activity Opportunities

According to standards for the strength of agreement proposed by Landis and Koch (1977) kappa statistics were calculated to examine associations of being in the 'more active' group across the four different physical activity variables examined. Substantial ($\kappa=0.68$) agreement between lunchtime recess and morning recess activity was noted, whilst fair ($\kappa=0.22$) agreement emerged for lunchtime recess and after-school activities. Slight agreement was observed for active transport with lunchtime activity ($\kappa=.03$), morning recess activity ($\kappa=0.18$), and after-school activities ($\kappa=0.11$), and between after-school activities and morning recess activity ($\kappa=0.18$).

Discussion

This study provides insight into the physical activity habits of low SES high school students in New Zealand across a segmented school day. While several opportunistic periods are available throughout a school day for youth to be active, a large proportion of teenagers are not as active as they could be with few youth engaging in physical activity across multiple time periods. Furthermore, substantially lower participation levels were observed during school hours (at recess and lunchtime) than time periods outside school hours (before and after school). Hence, high school students are not maximising all school day related opportunities to be active.

Although some (Duncan et al., 2006; Klasson-Heggebo & Anderssen, 2003; Trost et al., 2000) studies suggest young people are more active on weekdays than weekend days, our findings support the need for interventions targeting weekday activity to assist young people to increase their overall weekly physical activity level. Time periods like recess and lunchtime provide salient opportunities to implement physical activity strategies, and in turn, assist New Zealand high school students to accrue a large portion of the daily activity dose, like the accumulated levels noticed among children (Ridgers et al., 2005). Furthermore, increasing activity during these school day break times is of particular importance for adolescents who are not likely to be active outside of the school environment.

The level of active transportation noted in this study compares favourably to statistics from the United States (Martin & Carlson, 2005) and Australia (Lewis, Dollman, & Dale, 2007), where less than 30% of young people commute actively to and from school. The positive picture of active transportation among this sample, however, is likely a reflection of the type of schools included in the sample and familial constraints that exist within low SES families. Most participating schools were public schools which are more likely to be accessible by foot by students due to zoning regulations. Constraints faced by low SES families may also force the use of more active modes of commuting, as parents are likely to be working, potentially two or more jobs, and there may be a lack of useable motorised transport vehicles or family members available to drive the students.

When examining the level of association of being considered 'more active' between each physical activity variable, few associations were noted. The low level of agreement indicates that no one physical activity profile exists and that each student participates in various combinations of the physical activity variables measured. These results, therefore, support the need for strategies that promote involvement in multiple contexts, rather than focusing on one context or time period.

Ethnic, gender, and age related differences noted in prior studies (Eaton et al., 2006; Jago, Anderson, Baranowski, & Watson, 2005a) were observed among this sample. In accordance with national data from New Zealand (Parnell et al., 2003; Sport and Recreation New Zealand, 2003) females, senior students, and those from ethnic minority groups (e.g., Asian/Other) were

identified as at risk for low activity. Similar to prior research (Klein-Platat et al., 2005), students with very high central obesity were also less likely to be in the more active group during recess compared to their peers who had lower central adiposity.

A particular strength of this study was the large and ethnically inclusive sample. As well, this study examined physical activity participation during four time periods that exist within a segmented school day. The limitations of this study, however, need to be noted. As it was not the purpose of the larger OPIC project to obtain a nationally representative sample of youth but rather to over sample for Pacific Island youth with low socioeconomic status, the resulting sample is not representative of the New Zealand youth population. Although the sample composition is similar to that of the New Zealand high school population for gender (approximately 50% females), the sample differed substantially by ethnicity. The ethnic composition of the sample was 57% Pacific Island, 20% Māori, 12% European, and 11% Asian and Other compared to 7.6%, 24.5%, 62.4% and 5.0%, respectively, for the New Zealand child population (<15 years old). The generalisability of the findings to the New Zealand youth population is to be interpreted with some caution. While the sample was drawn solely from the New Zealand population, the findings are relevant to other developed westernised countries that share similar characteristics to that of New Zealand. Another limitation is the use of self-report measures, an unavoidable limitation as contextual information can only be confirmed by this method. To enhance accurate recollection, the questionnaire chosen incorporated previously recommended approaches (Baranowski, 1988) including a short monitoring frame (1-week) and the use of a segmented day approach. Furthermore, there was no measure of overall daily physical activity, and neither duration nor intensity of physical activity was captured. Therefore, the contribution physical activity in these time periods makes to overall physical activity, which is clearly very important, could not be determined. Nor are we able to examine the percentage of students meeting the current moderate-to-vigorous physical activity recommendations (Strong et al., 2005). These analyses, however, could be determined if both accelerometers and a self-report tools (e.g., activity log) were employed. Other limitations include the use of cross-sectional data, thereby reducing the ability to examine changes in physical activity during the high school years longitudinally. Also the use of common anthropometric

measures likely reduced our capacity to accurately measure the adiposity-physical activity relationship.

To increase the study's external validity, replication of the findings within a representative sample of high school students using objective physical activity measures is required. To determine priority time periods to target, examining the contribution physical activity during each time period makes to total daily physical activity is necessary. In order to modify activity levels, examination of how physical and social environmental variables interact to impact participation levels is required. In turn, such information has the potential to influence new and existing school policies surrounding physical activity provisions.

Chapter 8: Youth Perceptions of Physical Activity

Preface

Chapters 6 and 7 provide empirical evidence of where, when, and if a sample of low socioeconomic high school students are active. Overall, few students are active, especially during recess and lunchtime periods. To assist these young people to be active, an understanding of the factors that shape whether they engage (or not) in active pursuits is required. To ensure the interventions developed are youth centred, efficacy of future interventions will be enhanced by engaging youth during the entire intervention process (development through to implementation). Taking a youth focused approach, a sample of junior high school students was consulted, through focus groups, to gain insight into the perceptions New Zealand youth hold regarding the benefits of, and barriers to, physical activity as well as potential strategies to increase participation in various domain-specific activities. As ethnic differences in physical activity levels are often reported in literature, a key focus for this article was to examine whether ethnic perceptions differ between Māori and New Zealand European students.

Introduction

During adolescence, physical activity is acknowledged to play an important role in the prevention of obesity, (Goran, Reynolds, & Lindquist, 1999; Janssen et al., 2005) and in health promotion in general (Department of Health, 2004). As in many countries (Craig et al., 2001; Grunbaum et al., 2002), inactivity is prevalent among the youth population in New Zealand (Sport and Recreation New Zealand, 2003), which has likely supported the burgeoning obesity epidemic. More research aimed at understanding how to increase physical activity behaviours of youth is therefore necessary. Consulting with and engaging high school students in the development phase of interventions has the potential to improve the efficacy of future efforts aimed at combating health issues faced by youth, including inactivity.

Previous research has explored the perceptions children (Leslie et al., 1999; O'Dea, 2003; Wilson, Williams, Evans, Mixon, & Rheaume, 2005) and adolescents (Allison, Dwyer, & Makin, 1999; Kubik, Lytle, & Fulkerson, 2005; O'Dea, 2003; Robbins, Pender, & Kazanis, 2003; Schofield et al., 2002; Taylor et al., 1999; Tergerson & King, 2002; Utter, Denny, & Watson, 2004) hold about physical activity participation, particularly in relation to the perceived barriers and benefits. Activity contexts such as active transportation, structured sport, and physical education are now considered important opportunities through which youth can achieve their daily activity dose. To our knowledge, the examination of youth perceptions towards various activity contexts, with the exception of physical education, has not been examined among high school students.

As a consequence of research exploring perceptions about physical activity, potential strategies for promoting physical activity are often cited from a researcher perspective, with little involvement from the target population (the youth themselves). Only three studies have examined potential activity promoting strategies as part of a focus group discussion with youth (Kubik et al., 2005; O'Dea, 2003) or children (Wilson et al., 2005). Studies reported a strong focus towards environmental strategies which targeted young people's home, school, and neighbourhood environments.

The available literature regarding youth perceptions of physical activity must be considered in light of several limitations. First, questionnaires are frequently used to examine perceptions, limiting the findings to a list of

predetermined and possibly biased perceptions. Second, perceptions of teenagers are often examined in terms of physical activity in general, with little exploration of perceptions around specific activity contexts (structured sport, active transportation, physical education classes). Third, few studies have examined sex- or ethnic-specific perceptions.

The aims of this study are three-fold. To explore, according to gender and ethnicity, high school students' perceptions regarding (i) the benefits of physical activity, (ii) the barriers to participating in various activity contexts (e.g., active transportation, PE, lunchtime activity), and (iii) potential activity promoting strategies from an ecological perspective.

Methods

Sample

A convenience sample of high school students from three schools situated within metropolitan Auckland, New Zealand were approached to take part in this study. The schools were matched in terms of socioeconomic status using the school decile rating, a proxy for socioeconomic status ranging from 1 (most deprived) to 10 (least deprived). Each school involved had a decile rating of two indicating low socioeconomic status. Depending on the school, the proportion of Māori students on the school roles varied between 20% through to 100%, whereas New Zealand European students comprised between 0% and 37% of the school roles (Education Review Office, 2002a, 2002b, 2004). A teacher at each school was approached to nominate approximately 24 students from Year 9 and 10 (13 to 15 years old) with varying activity levels and who identified themselves strongly as either Māori (indigenous people of New Zealand) or New Zealand European. In total, 44 participants took part in focus group discussions, 24 females and 20 males. Māori participants comprised just over 50% of the female (n= 13) and male (n=11) sub-samples.

Focus Group Procedure

A total of nine focus group sessions were conducted on school premises at a time suitable for both the school and the participants. The focus groups were separated according to ethnicity (Māori, New Zealand European) and gender, and included a maximum of six participants (range: 3 to 6 participants) in each group. Focus group sessions lasted approximately 50 minutes. All focus

groups were conducted by the primary author, who has experience with high school youth through extensive coaching experience and who is currently undertaking doctoral studies in the area of youth obesity and physical activity. Two Masters level students were recruited to take notes during each session. The study was approved by the Auckland University of Technology Ethics Committee (Appendix I). Consent was obtained from a school authority, and assent and consent from each participant and their parent, respectively. Copies of the consent forms and information sheets are provided in Appendices J to O.

Focus Group Schedule

Focus group discussions were based upon a standardised semi-structured interview schedule (Appendix P). General areas included in the schedule were (1) perceived benefits of physical activity, (2) perceived barriers to various activity contexts (e.g., structured sport, active transportation, physical education classes), and (3) potential strategies to increase physical activity levels of high school students. The focus group schedule included broad open-ended questions to elicit as wide a range of responses as possible. Content and face validity of the schedule were assessed during the development stage of the interview schedule. Experts in the field of qualitative research examined the schedule to ensure appropriateness in terms of question structure and schedule length, while physical activity experts reviewed the content of each question. As a result of this process the schedule was downsized to include three key questions as outlined in Table 19.

Table 19: Core Focus Group Questions

-
1. What are some of the benefits of participating in physical activity for you and other young (*Māori / New Zealand European*) people?
 2. Why are you and other young (*Māori / New Zealand European*) not physically active?
 3. What could be done to help you and other young (*Māori / New Zealand European*) people be more physically active during (*school, weekend, after school, getting to school*)?
-

For each question a set of probes were developed to be used to generate discussion. The four probes for Question 1 were social benefits, physical benefits, sport performance benefits, and psychological benefits of being active. The probes for Question 2 surrounded various activity contexts,

including active transportation, lunch break activities, physical education classes, after-school period, and weekend physical activity. For Question 3, an ecological approach was used to examine potential strategies for increasing activity levels of young people. A key aspect of taking an ecological approach (Spence & Lee, 2003) is to examine potential strategies from an individual and an environmental perspective. To achieve this, Question 3 was framed to ask how they could help themselves be active and how their family, school, and neighbourhood could also help them be more active.

Focus Group Analyses

In addition to the note taker, all focus group discussions were audio-taped to ensure all discussion points were captured. Thematic induction using the long table approach (Krueger & Casey, 2000) was employed to analyse the content of the transcribed manuscripts and notes obtained during the focus groups. The long table approach involved positioning a hardcopy of each quote under its respective question heading. Under each question heading like comments were grouped together. The extensiveness, emotion, and specificity of the quotes were considered to help determine common, dominant, and significant themes inherent in the raw data.

Results

Perceived Benefits of Participating In Physical Activity

As highlighted in Table 20, benefits centered on five major themes relating to fun, achievement, physical, psychological, and preferential activity factors. Participant quotes supporting each theme are also included in Table 20. Fun emerged as a benefit which was a product of the socialisation aspect of physical activity (e.g., “hang out with friends”). For males, extrinsic achievement factors including social recognition of their abilities by peers and aspirations for higher achievements were articulated. For females, winning was an extrinsic benefit, however, intrinsic benefits were also communicated (e.g., learning new skills). Another gender difference arose regarding physique related benefits. Although both genders articulated appearance based benefits, for females, this related to “feeling skinnier” and “not fat”, while males expressed more physical performance benefits (e.g., stronger and faster).

Table 20: Perceived Benefits Identified

Major Themes	Sub-Themes	Comments
Fun	Game quality Socializing	“Just the games that we play” “Cos it is fun playing with your friends”
Achievement	Aspirations Social recognition Self –development	“So you can go onto better things like the All Blacks” “committed to our sport”, “so you can be better it” “Say you are really good at sports and you achieve something they might say something at assembly and people will get to know you” “Learn new skills”,
Physical benefits	Appearance Physical performance Health benefits	“...to get better at it (sport)” “Makes you feel skinnier...” “Keeps yourself looking good” “Build up your upper strength, hits in rugby” “Stronger and quicker” “Do swimming for my breathing” “Helps asthma, it develops your lung,...” “If you get fat ... more chance of getting heart disease”
Psychological benefits	Mood Confidence	“just feel better about yourself” “like if you win a game you feel good but then if you lose you feel real stink and that you suck” “calms me down, release anger” “..in your first game you’re not confident, ... it will be like that was cool so you keep playing and playing because you are confident in yourself” “Makes you want to try new things, expand on new sports,..” “you know what you are doing and you don’t need to hide”
Preferential activity	Best available option	“Don’t have to look after by brothers” “Get away from mum she makes me do work chores” “There’s nothing else to do”

Psychological benefits were identified as a reason to be active but were less important than other themes identified. Males expressed activity as a cathartic experience for releasing anger and achieving a state of calmness. Females, but not males, indicated physical activity participation can result in a “confidence boost” which in turn can also help young people “try new things” and “expand on new sports you haven’t tried before”. Irrespective of gender, physical activity was a preferential option over other social responsibilities including doing chores or looking after siblings, and was considered an option when there was nothing else to do.

Barriers to Participating in Physical Activity

Table 21 shows the themes that emerged around the barriers to participating in physical activity and quotes related to individual themes. Participants portrayed a sedentary lifestyle and preference towards sedentary activities that transcended across various environments. Families provide easy access to sedentary activities, and passive transportation modes, while schools restricted access to the use of sporting equipment and the gymnasium at lunchtime, which underpins young people’s belief that there is “nothing to do at lunchtimes”.

Of the activity opportunities that are available at school, female participants’ highlighted structure-based barriers surrounding sport participation and PE classes. Trialling for sports teams, the seriousness of participation, limited team numbers, and the lack of social teams were reported barriers to sport participation. Barriers to PE, at least for New Zealand European females, included a dislike of performing activities in front of other class members singularly. Also, for females, perceived incompetence and perceptions of peer judgments were noted as barriers, which in turn, inhibited involvement in PE classes and trialling for sport teams (e.g., “People in teams are better than us, higher than us, will show us up”).

Table 21: Perceived Barriers Identified

Major Themes	Environment	Sub-Themes	Comments
Supportive sedentary environments	Home	Electronic devices	“talking on the phone” “listening to the radio” “Watching television”
		Passive transportation	“Your friend’s family is driving down the road they will stop and pick you up”. “There is always a car to get dropped off in” “If you can do those things like catch the bus why would you want to walk I wouldn’t want to”.
	School	Accessibility and availability	“nothing to do at lunchtimes” “Because the school doesn't lend the equipment”
Peer influences	Friends	Lack of peer support	“My friend just wants to sit down and listen to music”, “Sometimes your mates just don’t want to [play] no point in playing”)
		Social belonging	“If you’re not up with playstation games or computer games or watch the newest programme you don’t know what they [other students] are talking about” “If you don’t socialise you will be antisocial and no one will like you”
		Perceived Incompetence	“People in teams are better than us, higher than us, will show us up” “...don’t want to play because you think you are going to let the team down”.
Structure of physical activity opportunities	School	Sport	“Don’t want to be shamed out [when trialling]” “Teams are graded not just for fun just put the good people in it” “People take it too serious” “Nah there are only a certain number that get chosen for it that is why not most people go and join sports because of that....trials”
		Physical Education	“The way we do it (activities in PE classes) is stupid because everyone watches you and then laughs” “Some people don’t share like the boys in our class” “Tell the teachers not to make us do running”

Table 21 Continued: Perceived Barriers Identified

Major Themes	Environment	Sub-Themes	Comments
Physical constraint	Neighbourhood	Distance	"I would have to walk to school from Mangere bridge" "Live far away easiest way [by car] to get to school" "If you can do those things like catch the bus why would you want to walk I wouldn't want to" "Too far...there is like hills and everything so I am not going to walk" "Too far to walk [to school]" "It's 11km from my house to the bus stop and I catch a bus to here [school] so I can't walk"
		Safety	"Lots of hood rats down my street" "Some of them walk around in gangs makes you want to hurry up and get home" "Parks – only safe in some parts"
Motivation Level	N/A	Low motivation	"can't be bothered"
Lack of time	Home, School	School, home, and work related duties	"Get up late won't have time [to walk to school]" "Take too long to shower in the mornings" "No time to do it all"

Peer influences also negatively affected participation in general. Lack of interest from friends to be active, absence of people to be active with, and expectations to partake in passive socialisation during lunchtime were reported barriers. Social belonging was a peer-related barrier articulated by New Zealand European males who stated that, “If you’re not up with playstation games or computer games or watch the newest programme you don’t know what they (other students) are talking about” and, “If you don’t socialise you will be antisocial and no one will like you”.

Barriers surrounding active transportation to school were predominantly physical in nature including travel distance, lack of time and, to a lesser extent, safety related concerns, especially for females. Lack of motivation to actively commute was also expressed considering other passive modes are readily available (e.g., “There is always a car to get dropped off in”).

Physical Activity Enhancing Strategies

The strategies identified to enhance physical activity are summarised in Table 22. Two out of the three strategies were related to environmental factors. Both physical (e.g., accessibility, availability) and social (e.g., social support) aspects of the participants’ proximal environment were noted. The third strategy related to individual approaches.

Greater accessibility to, and availability of, activity opportunities at school, and to a lesser extent, around the neighbourhood were reported as possible strategies to increase physical activity. In addition to structured sport, more fun-based activities could be held during both the school day and after school. Females, in particular, expressed the need for “more sports teams” and the wish that, in addition to traditional sports like rugby and soccer, “a wider range of sports could be offered”. Greater access to sporting equipment at school during lunchtime and implementation of organised activities at lunchtime and after school were also suggested. Modifying the current PE curriculum was another school-based strategy recommended. Suggested modifications, however, were gender specific. Male participants recommended “more PE classes” per week and the potential for “PE homework”. Females, however, alluded to the activities conducted within PE classes, suggesting certain activities should be excluded (e.g., fitness, running) and that teachers could involve students in the decision-making process of choosing specific activities

for the session. Female participants also felt teachers could “teach you how to (play) so you can have fun and you know what you are doing”.

Neighbourhood modification referred to developing more activity locations, for instance, “parks”, “basketball courts”, “bike tracks”, and “rock climbing walls”. A female participant, who resided in a rural location, also suggested “more sidewalks”. Creating more neighbourhood-based “fun days” was also suggested by New Zealand European female participants.

Participants also expressed the need for more support in the form of encouragement and/or involvement from their friends and family. For females, joining a team with a friend could overcome barriers related to lack of support (e.g., “...you can both enter in a team then you would know someone there, you might not want to join because you don’t know anyone”) and low perceived competency (“If you do something wrong...(they are] laughing with you not at you”). Friends could also provide encouragement by providing guidance of how to play the sport. To a lesser extent, parent-based approaches, including more logistical support, encouragement, and parental policies, were suggested. Logical support included providing transportation to activity locations, and being more involved with enrolling their children in physical activity programmes or teams. Male participants indicated parents could “push” them to be more active as a form of encouragement. Lastly, changes in parental policies that focus on limiting television watching could also be implemented.

Participants also expressed self-responsibility focused strategies, in that, being active was determined, in part, by their actions to be involved with existing activities, but also how they could fit activity into their daily lives. Partaking in active transportation (e.g., running or biking to school), organising sport teams with classmates, and bringing their own equipment to school were suggested. Getting up earlier to walk to school, although considered, was not believed to be a viable option. One female participant acknowledged her awareness of pedometers and how she found it useful in setting daily step-based goals.

Table 22: Potential Physical Activity Promoting Strategies Identified

Major theme	Environment	Sub- theme	Comments
Availability and accessibility	School	Create more activities	“more sports teams” “Need fun activities. Make it look like they want to join” “Have more fun day type things not sport days” “Wider range of sports like instead of just doing the main ones like soccer or rugby or volleyball” “Having more activities around the school”
		Modify the PE curriculum	“ Don’t do fitness ...I hate doing fitness just like doing the sport” “Ask us what we like first” “[PE teachers could] teach you how to do [play] and so you can have fun and you know what you are doing” “More PE” “Could get PE homework”
		Logistical support	“Give out sports gear (at lunchtime)” “..games...arranged” “Put out games and balls” “Set up activities”
	Neighbourhood	Modify the physical environment	Parks” “Basketball court” “Bike tracks” “Rock climbing [wall]” “There is nowhere to ride your bike the closest arena... is about 20 minutes away, 10 minute drive 20 minutes to walk”
		Create more activities	“Fun days” “Have fun little sports days...”

Table 22 Continued: Potential Physical Activity Promoting Strategies Identified

Major theme	Environment	Sub- theme	Comments
Peer and familial support	Friends	Peer involvement	<p>“ [friends] can come and play its boring by yourself”</p> <p>“My class made up an indoor cricket team last year that was good”</p> <p>“Well if they [a friend] joins a team you might want to join with them you can both enter in a team then you would know someone there you might not want to join because you don’t know anyone”</p> <p>“If you do something wrong ..[they are] laughing with you not at you”</p> <p>“Helps to have someone to go with you if you wanna go for a run...”</p>
		Peer encouragement	<p>“Could encourage you to get into teams”</p> <p>“Can help you learn new skills... well say they had played longer than you and you’ve just started they can like give you tips and pointers of how to play the sport”</p>
	Home	Logistical	<p>“Sign you up for activities”</p> <p>“Taking us out to places more ... beaches, pool, gym”</p> <p>“Get you in some teams or ask you what sports you like”</p>
		Encouragement	<p>“Could push us to do more sports or why don’t you join this”</p> <p>“They [parents] could ask you what sports you like”</p>
Self-responsibility	All	Self-reliance	<p>“Run home”; “Ride to school”</p> <p>“Join a sports team and if you don’t like that just join another one”</p> <p>“Bring [to school] rugby ball to play with stuff that you can protect”</p> <p>“My class made up an indoor cricket team last year that was good”</p> <p>“Go for a daily run”; “Play sports”</p> <p>“Get up earlier to walk to school”</p>
	NA	Motivational Assistance	<p>Pedometers”</p> <p>“I’d set myself a goal for how many steps and ...try and beat that everyday”</p> <p>“Be confident with what you are doing”</p>

Discussion

Consistent with previous research (Kubik et al., 2005; O'Dea, 2003; Tergerson & King, 2002), high school students in metropolitan Auckland verbalised several benefits of being active, including having fun, social recognition, socialising, and meeting new people. New Zealand youth also acknowledged physical activity as a preferential behaviour over home responsibilities (e.g., doing chores or looking after siblings) but not over recreational sedentary alternatives (e.g., television watching). This suggests that physical activity is not always the highest priority in young people's lives. This finding is not surprising considering their immediate environments (e.g., friends, school, home, and neighbourhood) were found to be encouraging of a sedentary lifestyle through a perceived lack of social and/or physical support, making healthy choices difficult.

Many of the barriers and potential strategies identified were related to high school students' perception of choice. Youth choices were compromised at school because of poor accessibility to, and availability of, activity opportunities at school lunchtime (e.g., limited access to sports equipment and the school gymnasium during lunchtime). Like a previous qualitative study with children aged 10 to 13 years old (Wilson et al., 2005), improving the choice of activity opportunities was a motivating factor influencing participation. In our study this referred to increasing accessibility to sports equipment, more organised activities, a greater number of sports teams, and a wider variety of sports or other activities as well.

Similar to Wilson et al (2005), increased choice also extended to PE classes. Participants expressed interest in being involved in decision-making processes during PE classes to determine the activities to be undertaken. This strategy could be reflective of adolescence, a period which is characterised by an increase in independence (Wilson et al., 2005). Increasing the weekly number of PE classes was also suggested. This strategy is supported by recent studies that found elementary (Henry et al., 1999) and secondary school students (Wilde et al., 2004) achieved higher activity levels on school days that included PE compared to those days without PE classes (Henry et al., 1999). Research examining the feasibility of providing a PE environment that incorporates student-driven activities, with the appropriate physical (e.g., variety

of activities) and social support (e.g., encouragement from teachers and peers) elements is, therefore, warranted.

Peers also influence young people's choice to participate in physical activity. Supporting this perspective, a recent study of high school aged females (Schofield, 2004) found that peers exhibiting a reciprocal friendship demonstrated a stronger correlation in activity behaviours (as measured by pedometry) compared to students in non-reciprocal friendships. Our findings provide further support for the strong influence of friends on young people's physical activity behaviour, in that, friends could either impede participation or be a potential supportive source of activity through verbal encouragement and role modelling. Although peer influences such as encouragement have been examined cross-sectionally, and shown only to be weakly correlated with global activity levels (Prochaska et al., 2002), friends may exert a stronger influence on context-specific activities such as sport participation and lunchtime physical activity. Furthermore, compared to parental influences, peer influences were articulated to a greater extent which supports previous research suggesting peers are a greater source of influence during adolescence (Wu et al., 2003).

Active commuting to school is a key strategy to help youth achieve their daily activity dose. Like previous research (Dellinger, 2002), our study found distance to be the main barrier impeding youth actively commuting to school. Distance, however, was compounded with families (both their own and their friend's) having automobiles readily available for passive transportation. This, in turn, could likely influence young people's lack of motivation to walk or bike to school, or to wake up early enough to overcome time constraints associated with active commuting.

In addition to school and peer influences, the findings also showed that neighbourhood factors (safety and accessibility to activity locations) influenced activity behaviours. Further exploration of environmental influence of youth activity behaviour is warranted considering that a recent nationally representative survey of New Zealand high school students reported that regular vigorous activity was negatively associated with safety concerns, while accessibility to activity locations increased the likelihood young people would be physically active (Utter et al., 2004).

Gender differences were apparent among participants, with females acknowledging structure-related barriers to participating in sport teams and PE

classes. Considering physical activity levels of adolescent girls decline during high school years (Schofield et al., 2002), providing positive experiences in such activities at school may assist in offsetting this trend. Modification of current legislative school policies regarding physical education classes and other school activity opportunities (e.g., more sport teams) is justified to ensure optimal engagement of students, both males and females, and those sport or not so sport minded, in active movement. A suggested strategy acknowledged in previous studies was same-gender physical education classes (O'Dea, 2003; Taylor et al., 1999) and physical activity programmes (Wilson et al., 2005) in general.

Both Māori and New Zealand European participants reported similar benefits, barriers, and potential strategies. Based on these results, the perceptions from which interventions can be based seem to be consistent across both Māori and New Zealand European cultures. Because all participants attended low decile schools, the commonality of their socioeconomic status (based on school decile rating) likely supported the congruence of perceptions between the ethnic groups. To further examine potential disparities in perceptions according to ethnicity, focus groups, including participants of various socioeconomic levels, could be conducted. Future research, however, should also examine perceptions according to socioeconomic status, because this has been shown to influence perceptions among the adult population (Wilson, Kirtland, Ainsworth, & Addy, 2004).

Although our study explored various activity contexts, it was evident from the group discussions that high school students perceived sport and physical activity to be synonymous terms. As a result, many of the reported findings are in relation to their thoughts about sport rather than physical activity *per se*. This observation is not surprising considering school physical education is sports driven and that parents are likely to portray this perspective as well. It is, therefore, not surprising that the strategies identified were very sport oriented. More focus towards providing youth with a greater knowledge about more general forms of physical activity and diverse modes of being physically active is warranted.

To help enhance physical activity levels among the youth population, a diverse range of strategies that transcended various environments including the school, neighbourhood, peer, and home settings were suggested by the

participants. This finding highlights the need for future interventions to incorporate a multi-strategy and multi-environment approach to enhance physical activity levels among teenagers. A coordinated approach between local authorities, government agencies (e.g., Ministry of Education), schools, families and neighbourhoods is required to address the policy, physical, and social-related strategies that were verbalised.

Strategies employed, however, should be individualised to the target community because appropriate strategies will likely differ according to community location (rural versus urban setting), target population (male versus female), and the community needs (i.e., what activity opportunities or activity promoting infrastructure is lacking?). In terms of gender, gender-specific physical education classes and allowing student input in determining the content of PE classes may help ensure PE provides a more positive physical activity experience, especially for females. Although some strategies did differ between genders, such strategies could potentially be applied to both genders (e.g., having a wider variety of sports available at school, not having to trail for sports teams).

Our study builds upon previous research by examining young people's perceptions towards specific activity contexts, as well as exploring their thoughts regarding potential strategies aimed at enhancing activity behaviours. In addition, our methodology allowed the examination of gender- and ethnic-specific barriers, which has been lacking in previous research. To the knowledge of the authors, only one other study has examined perceptions towards physical activity among New Zealand high school students (Utter et al., 2004). Although based on nationally represented dataset (Adolescent Health Research Group, 2003), only perceived benefits were determined using survey methodology, thereby, limiting responses to a pre-determined list of benefits.

Some potential limitations within this study need to be noted. The use of focus groups, and restricting participant demographics to certain school levels (Year 9 and Year 10) and specific ethnic groups (Māori and New Zealand European), limits the generalisability of our findings to other young people. Also, the generic demographics of groups do not allow examination of the perceptions according to weight status or activity level. Additionally, the sample was one of convenience and only included schools with a low decile rating.

The importance of environments on health behaviours such as physical activity is gaining momentum and attention from researchers, policy makers, and local authorities. Our findings provide further support for developing environment-focused strategies to increase physical activity participation of youth in various activity contexts (PE, active transportation). Also, when developing strategies, the discrete needs of both females and males need to be considered.

Chapter 9: Social Support and Youth Physical Activity: Importance of Siblings, Cousins, Parents, Friends, and School Support

Preface

Findings highlighted in Chapter 8 show support for the strong influence of friends and parents on young people's physical activity behaviour, and that these social networks could either impede participation or be a potential supportive source of activity. While a positive link between social support and youth physical activity is evident, findings to date are predominantly based on two sources of support (parents and friends) and are limited to assessing global physical activity levels (rather than context, or location specific activities). From an ecological perspective the most proximal sources are poised to have the greatest influence, therefore, it is likely the relative influence of these support sources will differ depending on the domain or activity examined. Extending current knowledge, the study presented in this chapter examined the importance of perceived encouragement from parents, friends, and other social networks across three time-specific activity opportunities that are available during a school day (e.g., after-school, lunchtime, active transportation).

Introduction

The high school years is a period of life consistently associated with a subsidence in physical activity levels (Anderssen et al., 2005; Kimm et al., 2002; Klasson-Heggebo & Anderssen, 2003; Telama & Yang, 2000; Van Mechelen et al., 2000). To slow down or reverse this trend, gaining a greater insight into the determinants of youth physical activity is required. Determinant-based frameworks of physical activity have been developed which focus on broad, multilevel, ecological health promotion approaches that work toward understanding the modifiable social and physical environmental determinants of physical activity (Spence & Lee, 2003; Welk, 1999). Despite the recent upsurge and popularity in studies examining how the physical environment influences physical activity habits, further research into the relative importance of social support from various sources continues to be advocated (Springer et al., 2006).

Encouragement, role modelling, and logistical support are all examples of social support that have been positively associated with youth physical activity participation (Anderssen & Wold, 1992; Cleland et al., 2005; Davison & Schmalz, 2006; Gottlieb & Chen, 1985; Hoefer et al., 2001; McGuire et al., 2002; Neumark-Stzainer et al., 2003; Schofield et al., 2007; Springer et al., 2006; Trost et al., 2003; Wold & Anderssen, 1992). Among these elements, however, encouragement may have a longer lasting effect on behaviour change, because not only does encouragement act directly on physical activity, but also indirectly through its influence on self-efficacy (Biddle & Goudas, 1996; Trost et al., 2003), a key psychosocial variable repeatedly found to be associated with physical activity among young people (Motl et al., 2007; Motl et al., 2005a; Neumark-Stzainer et al., 2003; Strauss et al., 2001; Trost et al., 1997; Trost et al., 2003; Wu & Pender, 2002; Wu et al., 2003).

Physical activity research has focused predominantly on two sources of encouragement - parents and friends - with little consideration of encouragement provided by siblings, extended family members (e.g., cousins), and schools. In New Zealand, living with extended family members is common among certain ethnic groups (e.g., Pacific Islanders) and therefore needs consideration (Statistics New Zealand, 2002). When parental support has been examined, family type (e.g., no parents, two parent family, and single parent family) has rarely been considered. In 2001, 29% of families with dependent children in New Zealand were single parent families, placing New Zealand only

behind America as having the second highest percentage of sole parent families among OECD countries (Ministry of Social Development, 2006). Considering single parent families are disadvantaged economically and socially when compared to two-parent families (Ministry of Social Development, 2006) examining the influence of family type on youth physical activity levels is warranted. Furthermore, adolescence is a period of life characteristic of increasing independence from families and expanding social networks external to the family environment (Eccles, 1999).

While prior studies support the encouragement-physical activity link, the studies have lacked diversity in the range of physical activities examined. Participation in vigorous or moderate-to-vigorous intensity physical activity has typically been examined with little attention directed toward activities undertaken at specific time periods or segments of a school day (e.g., after-school activity, lunchtime activity, before school through active transportation) in which young people can be active. Ecological models, which are holistic and consider both individual and environmental correlates of the targeted behaviour (e.g., physical activity) posit that influencers most proximal to the target group will have the strongest effect on the desired behaviour (Spence & Lee, 2003). Hence, the importance of support from parents, friends, siblings, and schools is likely to be dependent on the location, period of the day, and context of physical activity examined. Initiating this type of investigation, authors of a recent study of Norwegian youth aged nine or 15 years old concluded that psychosocial correlates of physical activity appear to be location specific, but further examination is warranted to provide deeper insight (Ommundsen et al., 2006).

To overcome the identified gaps in literature, the aim of the current study was to simultaneously examine the importance of perceived encouragement from parents, siblings/cousins, friends, and schools on participation in after-school physical activities, lunchtime physical activity, and engagement in active transportation to and from school.

Methods

Data Collection

The OPIC (Obesity Prevention In Communities) project is an obesity prevention initiative focusing on high school aged students which is being conducted across four countries (Australia, New Zealand, Fiji, and Tonga).

Within each country the project is being carried out within a predetermined suburb/ neighbourhood. The measures and data of this study represent a portion of the variables and data collected from schools participating in the New Zealand aspect of the OPIC project. Ethics approval for the project was gained from the University of Auckland Ethics Committee (Appendix Q).

Sample

Students were recruited from seven low socioeconomic status (decile rating of 1 or 2) high schools located in South Auckland, New Zealand. The decile rating, which ranges from 1 (most deprived) to 10 (least deprived), indicates the extent to which the school draws its students from low socioeconomic communities.

Based on school enrolment numbers, the response rate varied by school, and ranged from 25% up to 78% (school average = 58%). For all schools combined, the original sample surveyed in 2005 was 3,581 (response rate of 53% from 6,827). Of this total, 14 participants (0.4%) were excluded due to not meeting age criteria for inclusion (i.e., 12-18 years old, inclusively) and a further 96 participants (2.7%) were excluded as a result of incomplete data. Therefore, the final sample consisted of 3,471 participants (97% of the original sample surveyed) with a mean age of 14.8 ± 1.4 years, and a composition of 48% male, 72% junior students (Years 9-11) and a mix of different ethnicities (Pacific Island descent, 57%; Māori, 20%; European, 12%; Asian/Other, 11%). Written consent was gained from all students. For students aged below 16 years written parental consent was obtained for most students with a small number of parents providing consent orally over the phone. Consent was also gained from the Principal of each school. Copies of the consent forms and information sheets are provided in Appendices R to W.

Measures

Physical activity, perceived encouragement, and demographic variables were collected using an electronic (i.e., personal digital assistant, PDA) self-report questionnaire administered during a scheduled class time. A full copy of the OPIC survey is presented in Appendix X. A pilot study of the survey was

conducted with four classes, one class at each year level (Year 9 through to Year 12), to examine comprehension level and survey completion time.

Demographic Variables The questionnaire requested information on age, gender, and ethnicity. For ethnicity, participants selected the main ethnic group with which they identified from a list of New Zealand relevant ethnic groups. For the purpose of analyses, students in Years 9, 10, and 11 were grouped as junior high school students, while senior high school students refers to those participants in Years 12 and 13.

Physical Activity Variables The questionnaire contained three separate items to assess physical activity in the form of active transportation, activity during lunchtime and activity during the after-school time period. These items were replicated from the New Zealand Children's Nutrition Survey (Parnell et al., 2003), a national survey of physical activity and nutrition among children. The New Zealand Children's Nutrition Survey was based on the Physical Activity Questionnaire for Children (PAQ-C), a questionnaire that has demonstrated acceptable reliability and validity (Crocker et al., 1997; Kowalski et al., 1997a; Kowalski et al., 1997b). Of the items that comprise the New Zealand Children's Nutrition Survey, questions that individually examined after-school activity and lunchtime activity were used in this study. Face/content validity of each question was assessed by the authors, and participant comprehension was tested during the piloting of the entire OPIC survey.

For after-school physical activity participants were asked to self-report the number of days (0 to 5 days) over the previous five school days they participated, after school, in sports, dance, cultural performances, or played games in which they were active. Based on their self-reported level of participation, participants were dichotomised into "active" (i.e., participated in after-school activities on at least three school days) or "less active" (i.e., participated in after-school physical activities on two or fewer days) groups.

In terms of lunchtime physical activity, participants were asked "over the last five school days, what did you do most of the time at lunchtime (apart from eating)". Participants chose one of the following three response options: 'mostly just sat down', 'mostly stood or walked around', or 'mostly played active games'. Based on their self-reported level of participation,

participants were dichotomised into “active” (i.e., mostly played active games) or “less active” (i.e., mostly just sat down or mostly stood or walked around) groups.

For active transportation, each participant reported the number of trips he/she made by biking or walking to or from school over the previous five school days. Based on their self reported level of participation, participants were dichotomised into “active” (i.e., walked/biked to or from school for at least five trips in the previous school week) or “less active” (i.e., walked/biked to or from school for fewer than five trips in the previous school week) groups.

Perceived Encouragement Similar to items used in previous studies (Sallis et al., 2002; Trost et al., 2003), perceived encouragement from the participant’s mother, father, older brothers/male cousins, older sisters/female cousins, friends, and school was assessed individually using the following question format; “How much does your [*support source*] encourage you to be physically active or play sports”. Participants responded using a five-point response scale (a lot, some, a little, not at all, don’t have/live with my [*support source*]).

Due to the potential of collinearity to occur between certain support sources, responses for maternal and paternal support were combined into a single independent variable referred to as ‘parental encouragement’ whilst responses for brother/male cousin and sister/female cousins were combined to form the independent variable of ‘sibling/cousin encouragement’.

Based on their survey responses, participants were grouped into ‘high’ (i.e., reported receiving a lot of encouragement) and ‘low’ (i.e., reported receiving some to no encouragement) encouragement groups for each support source. The groups were then further divided according to their family structure (e.g., single parent family, two parent family, no parents) which was constructed from the participant’s responses to maternal and paternal encouragement questions.

For parental encouragement, participants were classified as either receiving (1) high support from both parents in a two parent family, (2) high support from at least one parent from a two parent family, (3) high support from one parent within a single parent family, (4) low support from both parents within a two parent family, and (5) low support from their sole parent

within a single parent family or does not live with his/her parents. In terms of sibling/cousin encouragement, participants were classified into one of three groups; high support from older brothers/male cousins or older sisters/female cousins, low (but not high) support from either older brothers/male cousins or older sisters/female cousins, and does not have older siblings/cousins. For friend and school support, participants were grouped as either receiving high support or low support from each support source.

Data Analysis

Data were analysed using Statistical Analysis System (SAS) version 9.1 (SAS Institute Inc., Cary, NC, USA), with corrections for any design effects arising from sampling students by class. Using binary logistic regression both univariate and multivariate analyses were conducted to calculate odds ratios (crude and adjusted, respectively) and 95% confidence intervals. Both univariate and multivariate models were adjusted by sex and ethnicity.

Developing the multivariate model consisted of a two-step process. First, the 'Proc Logistics' procedure in SAS was conducted to identify significant predictor variables based on mutual adjustment of all predictor variables while adjusting for sex and ethnicity also. All predictor variables with a p-value below 0.05 were identified and kept for the final multivariate model. As the variables had not been corrected for cluster sampling during this process, the final model was then tested through the 'Proc Surveylog' procedure to calculate adjusted odds ratios (OR's) and 95% confidence intervals (95% CI) that were adjusted by sex and ethnicity and corrected for cluster sampling.

Results

After-School Activity

Univariate analyses (Table 23) showed that encouragement from all sources (with the exception of school support for senior students) was significantly associated with frequency of after-school physical activities. After conducting the stepwise process, encouragement from parents (junior students, $p < 0.0001$; senior students, $p < 0.0001$) and friends (junior students, $p < 0.0001$; senior students, $p \leq 0.0001$) remained significant across all groups while older sibling/cousin support was only significant for junior students ($p = 0.0001$). As

shown in Table 23, these variables remained significant for their respective age groups in the multivariate model once cluster sampling was corrected for.

Based on the multivariate models (Table 23) youth who received low parental support were less likely to be considered active after school compared to youth who received high levels of encouragement from both parents. Also, youth who resided in a single parent family but received high support from their sole parent were just as active after school as youth who received high support from two parents. Among junior students with older siblings, those who received low support were less likely to be regularly active after-school. Furthermore, low friend support increased the likelihood of not being active after school with reported adjusted OR's of 0.61 (95% CI: 0.51-0.74) and 0.49 (95% CI: 0.35-0.69) for junior and senior students, respectively.

Table 23: Univariate and Multivariate Analysis of Perceived Support From Various Sources for Participation in After-School Physical Activity

Perceived Support	Juniors (n=2,490)				Seniors (n=981)			
	Total n	% active ^a	Univariate model OR (95% CI) ^c	Multivariate model ^b OR (95% CI) ^c	Total n	% active ^a	Univariate model OR (95% CI) ^c	Multivariate model ^b OR (95% CI) ^c
Parent(s)								
High (2/2 parents)	99	70.0	1.0 [*]	1.0 [*]	54	72.2	1.0 [*]	1.0 [*]
High (1/1 parent)	1,007	62.6	0.78 (0.47-1.29)	0.87 (0.53-1.44)	281	59.3	0.56 (0.30-1.06)	0.62 (0.33-1.16)
High (1/2 parents)	456	55.5	0.54 (0.43-0.68)	0.64 (0.50-0.80)	166	59.6	0.58 (0.39-0.86)	0.68 (0.45-1.01)
Low (2/2 parents)	753	44.1	0.36 (0.29-0.44)	0.47 (0.38-0.58)	390	42.1	0.33 (0.23-0.48)	0.41 (0.29-0.60)
Low (1/1, no parents)	175	41.1	0.33 (0.24-0.47)	0.46 (0.32-0.65)	90	36.7	0.25 (0.15-0.44)	0.31 (0.18-0.55)
Sibling/Cousin(s)								
High	1,241	67.9	1.0 [*]	1.0 [*]	392	65.1	1.0 ^{**}	
Low	1,095	46.5	0.45 (0.39-0.53)	0.66 (0.56-0.79)	515	47.0	0.54 (0.41-0.73)	
No sibling	154	46.8	0.51 (0.36-0.71)	0.71 (0.50-1.02)	74	45.9	0.65 (0.39-1.10)	
Friend(s)								
High	986	70.1	1.0 [*]	1.0 [*]	385	70.4	1.0 [*]	1.0 [*]
Low	1,504	48.7	0.45 (0.38-0.54)	0.61 (0.51-0.74)	596	43.6	0.40 (0.29-0.54)	0.49 (0.35-0.69)
School								
High	1,369	62.3	1.0 [*]		546	57.2	1.0 ^{ns}	
Low	1,121	50.9	0.67 (0.57-0.79)		435	51.6	0.85 (0.67-1.08)	

^a Participated in sport, dance, cultural performances, or played active games after school on at least 3 weekdays

^b Only variables found significant (p<.05) through the stepwise process were included in the final multivariate model

^c Corrected for cluster effect and controlled for sex and ethnicity

* p=<0.0001; ** p=0.0003; ns=non-significant

Lunchtime Physical Activity

Based on univariate analyses (Table 24), all sources of support (parents, friends, older siblings/cousins, and school) were significantly associated with being active at lunchtime for both junior and senior students. After conducting the stepwise process, only perceived friend support was significantly related to lunchtime physical activity levels for both junior ($p < 0.0001$) and senior ($p < 0.0001$) students. Parental support ($p = 0.01$) and school support ($p = 0.03$) also remained significant for junior students only. As shown in Table 24, these variables, with the exception of school support, remained significant for their respective age groups in the multivariate model once cluster sampling was corrected for. For both junior (OR: 0.39, 95% CI: 0.32-0.48) and senior students (OR: 0.41, 95% CI: 0.29-0.57), the multivariate models show that students reporting low peer support are less likely to be categorised as active (i.e., mostly played active games) compared to those reporting high levels of encouragement from friends. Also, among junior students from two-parent families, those receiving low support from at least one parent are less likely to be active during lunchtime with noted ORs of 0.68 (95% CI: 0.54 - 0.87) for students with low parental support from two-parent families and 0.77 (95% CI 0.59 - 0.99) for students with high support from only one parent from a dual parent family.

Table 24: Univariate and Multivariate Analysis of Perceived Support from Various Sources for Participation in Lunchtime Physical Activity

Perceived Support	Juniors (n=2,490)				Seniors (n=981)			
	Total n	% active ^a	Univariate model OR (95% CI) ^c	Multivariate model ^b OR (95% CI) ^c	Total n	% active ^a	Univariate model OR (95% CI) [‡]	Multivariate model ^b OR (95% CI) ^c
Parent(s)								
High (2/2 parents)	99	43.8	1.0 [*]	1.0 ^{****}	54	36.3	1.0 ^{***}	
High (1/1 parent)	1,007	33.3	0.82 (0.50-1.34)	0.92 (0.55-1.54)	281	31.5	0.92 (0.50-1.68)	
High (1/2 parents)	456	33.1	0.64 (0.50-0.82)	0.77 (0.59-0.99)	166	26.5	0.66 (0.44-0.99)	
Low (2/2 parents)	753	26.8	0.51 (0.40-0.65)	0.68 (0.54-0.87)	390	19.7	0.53 (0.37-0.76)	
Low (1/1, no parents)	175	24.6	0.49 (0.33-0.73)	0.70 (0.46-1.04)	90	17.8	0.49 (0.26-0.93)	
Sibling/Cousin(s)								
High	1,241	43.3	1.0 [*]		392	34.4	1.0 ^{**}	
Low	1,095	26.7	0.52 (0.43-0.63)		515	21.2	0.60 (0.45-0.79)	
No sibling	154	26.6	0.59 (0.39-0.90)		74	16.2	0.50 (0.21-1.19)	
Friend(s)								
High	986	51.8	1.0 [*]	1.0 [*]	385	39.7	1.0 [*]	1.0 [*]
Low	1,504	23.9	0.34 (0.28-0.42)	0.39 (0.32-0.48)	596	17.3	0.41 (0.29-0.57)	0.41 (0.29-0.57)
School								
High	1,369	39.2	1.0 [*]		546	30.3	1.0 ^{*****}	
Low	1,121	29.7	0.64 (0.52-0.79)		435	22.7	0.71 (0.51-0.98)	

^a Played active games most of the time

^b Only variables found significant (p<.05) through the stepwise process were included in the final multivariate model

^c Corrected for cluster effect and controlled for sex and ethnicity

* p=<0.0001; ** p=0.001; *** p=0.007; **** p=0.02; ***** p=0.04

Active Transportation

As shown in Table 25, univariate analyses identified that only peer support among junior students was significantly associated with frequency of active transportation (i.e., walking/biking at least five times to or from school over a school week). After adjusting for all predictor variables through the stepwise process, friend support ($p = 0.005$) and school support ($p = 0.04$) were significant for junior students. No significant variables emerged for senior students; therefore, no multivariate model was tested for this age group. For junior students, the multivariate model, once corrected for cluster sampling, shows that junior students who receive low peer support have a reduced odds (OR: 0.78, 95% CI: 0.66 - 0.92) of undertaking at least five trips to or from school by active transportation modes, while low school support was associated with an increased odds of commuting actively on a regular basis (OR: 1.20, 95% CI: 1.02 - 1.40).

Table 25: Univariate and Multivariate Analysis of Perceived Support from Various Sources for Participation in Active Transportation Association

Perceived Support	Juniors (n=2,490)				Seniors (n=981)		
	Total n	% active ^a	Univariate model OR (95% CI) ^c	Multivariate model ^b OR (95% CI) ^c	Total n	% active ^a	Univariate model OR (95% CI) ^c
Parent(s)							
High (2/2 parents)	99	61.6	1.0 ^{ns}		54	55.5	1.0 ^{ns}
High (1/1 parent)	1,007	59.6	0.90 (0.62-1.32)		281	59.3	1.22 (0.67-2.24)
High (1/2 parents)	456	60.7	0.97 (0.79-1.20)		166	53.6	0.96 (0.68-1.37)
Low (2/2 parents)	753	57.0	0.85 (0.71-1.03)		390	49.7	0.93 (0.68-1.28)
Low (1/1, no parents)	175	61.7	1.01 (0.74-1.39)		90	58.9	1.32 (0.77-2.26)
Sibling/Cousin(s)							
High	1,241	61.3	1.0 ^{ns}		392	57.1	1.0 ^{ns}
Low	1,095	58.8	0.91 (0.78-1.07)		515	52.2	0.89 (0.64-1.24)
No sibling	154	57.1	0.87 (0.62-1.22)		74	41.9	0.62 (0.40-0.96)
Friend(s)							
High	986	63.4	1.0 ^{**}	1.0 [*]	385	55.8	1.0 ^{ns}
Low	1,504	57.7	0.81 (0.69-0.95)	0.78 (0.66-0.92)	596	51.8	1.02 (0.77-1.36)
School							
High	1,369	58.4	1.0 ^{ns}	1.0 ^{***}	546	51.3	1.0 ^{ns}
Low	1,121	61.9	1.14 (0.98-1.33)	1.20 (1.02-1.40)	435	55.1	1.21 (0.91-1.61)

^a Walked/biked to or from school for at least 5 trips over the last 5 school days

^b Only variables found significant (p<.05) through the stepwise process were included in the final multivariate model

^c Corrected for cluster effect and controlled for sex and ethnicity

* p=0.004; ** p=0.01; *** p=0.03; ns=non-significant

Discussion

This study examined the importance of one form of social support (i.e., encouragement to do physical activity) from four support sources (parents, older siblings/cousins, friends, and schools) across three time-specific physical activities (after-school physical activity, lunchtime physical activity, and active transportation to and from school). A key and novel finding of this study was that the importance of encouragement from the various sources was dependent on the time-specific activity examined.

In line with prior research (Springer et al., 2006), we identified that encouragement from parents and friends was a key contributor to youth being active after school, irrespective of age cluster. During adolescence, therefore, both parents and friends play an important role in the socialisation of teenagers to after school activities. Students who reported receiving high support from at least one parent were just as likely to be active on most days during the after-school period, compared to their peers who received high levels of support from two parents. These findings provide a positive picture that youth from single parent families can be just as active after school as students from two parent families, as long as the available parent provides a high level of encouragement towards his/her offspring. Frequency of after-school activities was also significantly associated with peer encouragement, with students receiving limited support being less likely to be regularly active after school compared to their counterparts receiving higher levels of peer support. In addition, a significant association with older sibling/cousin support emerged for junior but not senior students. In particular, among junior students with older siblings/cousins, those who received high support were more likely to be active after school. The finding that the importance of older sibling/cousin encouragement differed by age lends support to the perspective that during adolescence peers become powerful influencers, more so than family members; a similar finding was noted in prior research (Anderssen & Wold, 1992; Springer et al., 2006; Wold & Anderssen, 1992). This is not unexpected, and is likely a natural consequence of young people increasing their independence from families and expanding social networks external to the family environment as they move through adolescence (Eccles, 1999). Examining the sex, age, and number of siblings/cousins as well as the types of activities engaged in after-

school may, help provide further insight into why this association emerged for junior students only.

In contrast to the findings for after-school activities, friends emerged as the only consistent source of support associated with lunchtime physical activity levels across both age clusters. This provides support for ecological theory which postulates that influencers most proximal to the target group will have the strongest effect on the desired behaviour. During lunchtime and within a school setting the most proximal social force would be a friend which explains why students who reported receiving low support from their peers were more likely to sit, stand, or walk around during lunchtime rather than play active games. A significant association with parental support emerged for junior students only, with low parental support from two parent families reducing the odds of their offspring being considered active during lunchtime. For junior students, therefore, as long as they receive high support from either friends or parents, the probability of engaging in active play during lunchtime increases. The lack of an effect of parental encouragement on senior students is potentially indicative of the higher importance of peer influences with increasing age.

Perceived encouragement to be active was not associated with the regularity of walking or biking to and from school among senior students. For junior students, commuting actively to school was positively associated with friend support but inversely related to school support. The limited findings between perceived encouragement and active transportation is not unexpected as physical environment factors, which have been linked to both active transportation (Dellinger, 2002) and physical activity in general (Duncan et al., 2005; Giles-Corti & Donovan, 2002a; Humpel et al., 2002; Sallis et al., 2000), are more likely to impede students undertaking active transport than perceived encouragement. For instance, no matter how much encouragement parents provide for their children to be active, if the family lives too far from school commuting actively is less likely to occur. Considering active transportation occurs outside the home and school environments, examining social factors at the neighbourhood level (e.g., safety, people visible in the neighbourhood, level of neighbour interactions and cohesion) may provide further insight potential social factors associated with active transportation patterns to and from school.

A particular strength of this study was the large and ethnically inclusive sample. In addition, this study is one of the first to examine the influence of

perceived encouragement from various support sources across three time dependent physical activity opportunities that exist within a school day. Also, examining how many parents each participant lived with during a school week allowed the effect of different parental structures (single parent, dual parents, or no parents) to be investigated.

The limitations of this study, however, need to be noted. As it was not the purpose of the larger Obesity Prevention in Communities (OPIC) project to obtain a nationally representative sample of youth but rather to over sample for Pacific Island youth with low socioeconomic status, the resulting sample is not representative of the New Zealand youth population. Although the sample composition is similar to that of the New Zealand high school population for gender (approximately 50% females), the sample differed substantially by ethnicity when compared to national statistics. The ethnic composition of the sample was 57% Pacific Island, 20% Māori, 12% European, and 11% Asian and Other compared to 7.6%, 24.5%, 62.4% and 5.0%, respectively, for the New Zealand child population (<15 years old). The generalisibility of the findings to the New Zealand youth population, therefore, must be interpreted with some caution. Another limitation is the use of self-report measures (Sirard & Pate, 2001), an unavoidable limitation as information about participation in specific physical activity contexts (e.g., active transportation) can only be confirmed by this method. Although accelerometers allow examination of physical activity intensity during certain time periods throughout a day, it cannot always distinguish the specific context in which the activity is taking place (e.g., physical activity after school could be due to sports participation or transport related physical activity). Reducing the self-report monitoring period to the week prior to the questionnaire completion day along with recalling frequency of activity during specific time periods, potentially reduce the effect of known associative recall bias of self-reports (Sirard & Pate, 2001) when compared to longer monitoring frames or when specific duration of physical activities are examined. Although the encouragement questions were based on questions included in prior studies (thereby allowing cross study comparisons), the use of a single question may not accurately capture the complexity of perceived encouragement. Furthermore, school encouragement may have been interpreted differently among participants, in terms of source (e.g., support form head teacher, senior managers/teachers, physical education teachers) and type

of encouragement (e.g., supportive school ethos, instrumental support, verbal encouragement). Clarifying the definition of school support is required in future studies. Other limitations include the use of cross-sectional data, which limits the ability to examine the impact of perceived support on the development of physical activity levels during the high school years longitudinally. Also, only one type of perceived support was examined which prevented the impact of overall support on youth activity to be analysed.

The findings from this study highlight the importance of proximal social networks on youth activity which should be considered when developing policies and programmes looking to promote physical activity among young people. The findings also provide further evidence that parents and friends are the key social influencers of physical activity during adolescence. To determine the true effect of school support on adolescent physical activity, further research is required that utilises more in-depth and specific question(s) to assess school encouragement and the wider school environment that may impact on perceived encouragement (e.g., the school ethos).

Chapter 10: Associations between After-School Physical Activity, Television Use, and Parental Strategies

Preface

Based on the findings presented in the previous chapters, parents still exert influence on physical activity behaviours of high school students, irrespective of age and especially during the after-school time period. This time period between the final school bell and dinner time is considered a critical window for young people to achieve their daily physical activity dose. As noted in Chapter 7, over 40% of students reported to not engage in physical activity after school on a frequent basis. In Chapter 8, televisions (TV) were verbalised as a key barrier to youth being active.

While the evidence is equivocal, the existence of a TV-physical activity connect may be particularly perceptible during this after school period because the competition between sedentary activities and more active pursuits potentially heightens when time is limited. Hence, the two objectives of this chapter were to determine weekday television viewing behaviour and whether the well-known and cited displacement hypothesis is relevant during the after-school time period. Also, based on the physical activity and TV data, after-school activity profiles on young people (e.g., active but watch a lot of TV, active and watched little TV) and the associated prevalence each profile were determined, In addition to describing activity patterns and profiles, modifying unhealthy patterns is of public health importance. Extending the findings of the previous chapter, the effect of social (encouragement) and policy (e.g., TV viewing rules) related parental strategies were examined for their cumulative effect on youth being categorised into one of the four activity profiles mentioned previously (e.g., active and watch a lot of TV). The direction of this chapter adds to current international literature as little is known about the impact of home TV policies, nor the cumulative effect of parental practices that target the promotion of physical activity (e.g., encouragement) and reduction of sedentary behaviours (e.g., television restrictions) simultaneously. In addition, TV viewing habits and activity profiles of New Zealand youth is largely unknown.

Introduction

Suboptimal levels of physical activity and sedentary behaviours among youth (Cameron, Craig, & Paolin, 2005; Centers for Disease Control and Prevention, 2006b; Sanchez et al., 2007; Tammelin et al., 2007) are public health concerns because they predispose young people to increased risk of poor health (Boone et al., 2007; Hernandez et al., 1999; Janz et al., 2005; Strong et al., 2005). Among youth, these behaviours are mutually exclusive and are not simply a mirror image or opposite ends of a continuum ranging from sedentary to physically active. Youth, therefore, can display varying levels of both sedentary and physical activity behaviours concomitantly. For instance, 'techno-active' youth display high levels of both physical activity and TV viewing/video game usage (Biddle et al., 2003).

When physical activity and sedentary behaviours have been examined simultaneously, the purpose has typically been to examine the magnitude of the interrelationship. While displacement hypothesis, which posits sedentary behaviours displace time that could be spent in more active pursuits, is intuitively logical, when total physical activity is examined the evidence for this hypothesis is equivocal (Marshall et al., 2004; Scragg et al., 2006). More specifically, a recent meta-analysis of 33 studies found low support for the displacement hypothesis. The articles included were predominantly focused on the child population (not adolescents, which is the target population of this article) and typically examined total or intensity-related physical activity. Acknowledging this, the authors did conclude that the use of aggregated time-use patterns across a day or week (e.g., hours of TV viewing per day) can lead to the loss of temporal and environmental context of each behaviour (i.e., physical activity, TV viewing). As a consequence, trends of associations within the sampling periods may be lost or cancelled out. Considering this conclusion, the displacement hypothesis is more likely to be relevant during periods where time is limited and youth have the option of being either active or sedentary, for instance, during the after-school time period. Although few studies have examined this perspective, Hager (2006) found significant negative associations between TV viewing and activity counts for male participants during the after-school time period but no significant associations were found on weekend days. Considering this after school finding and the fact that a large

proportion of high school students are not regularly active after school (Hohepa, Scragg, Schofield, Kolt, & Schaaf, In Press), after-school physical activity became the key dependent variable for this article.

Modifying physical activity and sedentary patterns of youth is of public health importance. The correlates of such behaviours are multifaceted, however the family unit is consistently considered a critical micro-environment through which youth behaviours can be shaped (Adolescent Health Research Group, 2003; Hager, 2006; Ornelas et al., 2007; Welk, Wood, & Morss, 2003). During adolescence, the main agent(s) of change in families - the parents - continue to play a strong socialisation role in influencing their child's behaviour. Parental factors related to young people's engagement in physical activity and/or sport include role modelling (Anderssen & Wold, 1992; Cleland et al., 2005; Davison, 2004; Gottlieb & Chen, 1985), level of engagement and communication with their child (Ornelas et al., 2007), family cohesion (Ornelas et al., 2007), logistical support (Anderssen & Wold, 1992; Hoefler et al., 2001; Lau, Quadrel, & Hartman, 1990; Sallis et al., 1999; Trost et al., 2003), and encouragement (Anderssen & Wold, 1992; McGuire et al., 2002; Neumark-Stzainer et al., 2003; Springer et al., 2006). Parental factors that have been associated with young people's level of sedentary behaviours include restricting access to sedentary pursuits (Epstein et al., 2006; Epstein et al., 2005), establishing and enforcing rules regarding TV viewing (Gorely, Marshall, & Biddle, 2004; Norman, Schmid, Sallis, Calfas, & Patrick, 2005) and parental TV viewing habits (Gorely et al., 2004). While substantial evidence exists for the importance of social support strategies, less is known about the effect of policy-related parental strategies (e.g., TV viewing rules). Moreover, potential strategies to increase physical activity or reduce sedentary behaviours are often researched in isolation; as a consequence little is known about the cumulative effect of parental practices that target the promotion of physical activity (e.g., encouragement) and reduction of sedentary behaviours (e.g., TV restrictions) simultaneously.

The purpose of this chapter was to further investigate whether the displacement hypothesis explains the relationship between after-school physical activity and weekday TV use. A secondary purpose was to investigate the association between differing levels of parental practices

(e.g., presence/absence of physical activity encouragement and/or TV viewing rules) on their child's weekday activity behaviours (i.e., combined level of TV use and after school physical activity).

Methods

Data Collection

The OPIC (Obesity Prevention in Communities) project is an obesity prevention initiative conducted across four countries (Australia, New Zealand, Fiji, and Tonga) targeting high school students in a predetermined suburb/neighbourhood in each country. The measures and data presented in this chapter represent a portion of the variables and data collected from schools participating in the New Zealand arm of the OPIC project. Ethics approval for the project was gained from the University of Auckland Ethics Committee. Consent was gained from all students, parents of students aged below 16 years, and the Principal of each participating school. Copies of the consent forms and information sheets are provided in Appendices R to V.

Sample

Students were recruited from seven low SES (decile rating of 1 or 2) high schools located in South Auckland, New Zealand. The decile rating, which ranges from 1 (most deprived) to 10 (least deprived), indicates the extent to which the school draws its students from low socioeconomic communities. Based on school enrolment numbers, the response rate varied by school, and ranged from 25% up to 78% (school average = 58%). For all schools combined, the original sample surveyed in 2005 was 3,581 (response rate of 53% from 6,827). Of this total, 14 participants (0.4%) were excluded due to not meeting age criteria for inclusion (i.e., 12 to 18 years old, inclusively) and a further 96 participants (2.7%) were excluded as a result of incomplete data. Therefore, the final sample consisted of 3,471 participants (97% of the original sample surveyed) with a mean age of 14.8 ± 1.4 years, and a composition of 48% male, 72% junior students (Years 9-11) and a mix of different ethnicities (Pacific Island descent, 57%; Māori, 20%; European, 12%; Asian/Other, 11%).

Measures

Collection Process After-school physical activity, perceived encouragement, television use, television rules, and demographic variables were collected using a self-report questionnaire which was administered using an electronic device (i.e., personal digital assistant, PDA) during a scheduled class time. A full copy of the OPIC questionnaire is presented in Appendix X. A pilot of the survey was conducted with four classes (one class at each year level from Year 9 through to Year 12) to examine comprehension level and survey completion time.

Demographic Variables The questionnaire requested information on age, gender, and ethnicity. For ethnicity, participants selected the main ethnic group with which they identified with from a list of New Zealand relevant ethnic groups. For the purpose of analyses, students in Years 9, 10, and 11 were grouped as junior high school students, while senior high school students refers to those participants in Years 12 and 13 (i.e., the final two years of high school).

Youth Behaviours – After School Physical Activity and Weekday Screen Use The questionnaire contained one item to assess physical activity during the after-school time period. This item was directly replicated from the national New Zealand Child Nutrition Survey (CNS) (Parnell et al., 2003), a national survey of physical activity and nutrition among children. The New Zealand CNS survey was based on the validated Physical Activity Questionnaire for Children (PAQ-C) (Crocker et al., 1997; Kowalski et al., 1997a; Kowalski et al., 1997b). The question required participants to report the number of days over the previous five school days they participated after school in sports, dance, cultural performances, or played games in which they were active. Based on their self-reported level of participation, participants were dichotomised into ‘more active’ (i.e., participated in after-school activities on at least three school days) or ‘less active’ (i.e., participated in after-school physical activities on two or fewer days) groups. Face/content validity of the question was assessed by the authors, and participant comprehension was tested during the piloting of the entire OPIC survey.

While several forms of sedentary behaviours exist (e.g., television, videos, DVDs, game consoles, computers, radio), televisions remain the

dominant medium of small screen technology (Roberts, Foehr, Rideoour, & Brodie, 1999). Similar to questions utilised in a prior New Zealand national survey (Parnell et al., 2003) to capture television use, participants reported the number of days on which they watched TV, videos, or DVDs during the past five school days (response ranging from 0 to 5 days). Also, using a 5-point response scale (<1hr, 1hr, 2hrs, 3hrs, 4hrs, or \geq 4hrs), participants stated the length of time spent watching TV, videos or DVDs on the last school day they were watched. Data were collected across each school day, in turn, minimising the confounding effect of daily variations in TV viewing behaviours. In alignment with current recommendations of screen use (American Academy of Pediatrics, 1995; Department of Health and Ageing, 2004), sedentary behaviour was dichotomised as 'high TV' (\geq 2hrs of daily) and 'low TV' (< 2 hours daily) groups.

Representing the dependent variable, participants were categorised into one of four behavioural groups based on their reported levels of after-school physical activity ('more active' or 'less active' groups) and time spent watching TV ('high' versus 'low' TV). The four groups were: low TV /Active (LTV-A), low TV /less active (LTV-LA), high TV /Active (HTV-A) or high TV / less active (HTV-LA) with LTV-A being the reference group.

Perceived Parental Encouragement and TV Rules Similar to items used in previous studies (Sallis et al., 2002; Trost et al., 2003), participants indicated the quantity of encouragement they received from their mother and father, individually, to be physically active or play sports using a 5-point response scale (a lot, some, a little, not at all, don't have/live with my [social support]). Based on their survey responses, participants were grouped into one of two encouragement groups: 'high encouragement' (i.e., reported receiving a lot of encouragement from at least one parent) and 'low encouragement' (i.e., did not receive a lot of encouragement from any parent).

The variable 'perceived TV limits' was assessed using the following question format: "During the school week, do your parents (or caregivers) limit the amount of TV you are allowed to watch (including videos and DVD's)". Using a three-point response scale participants chose one of the following options: No limits, I can watch anything; Yes, but not very strict limits; or Yes, strict limits. Students who reported TV rules were present

(irrespective of level of strictness) were combined to form the group “TV rules are present” while the remaining students were categorised as “TV rules are absent”

As the independent variable, four perceived parental behavioural groups were developed based on participants’ reported levels of perceived encouragement (high or low encouragement) and TV rules (present or absent). The four groups are: high encouragement/TV limits present (high/present), high encouragement/TV limits absent (high/absent), low encouragement/TV limits present (low/present), or low encouragement/TV limits absent (low/absent) with high encouragement/TV limits present (high/present) being the reference group.

Data Analysis

Data were analysed using Statistical Analysis System (SAS) version 9.1 (SAS Institute Inc., Cary, NC, USA). Descriptive statistics (means, medians, and standard deviations) were calculated in terms of both sedentary behaviours and physical activity. Using nominal logistic regression for complex surveys, adjusted odds ratios (AORs) and 95% confidence intervals (95%CI) were determined and corrected for the cluster effects arising from sampling students by class and adjusted by sex and ethnicity. The LTV-A youth behavioural group (dependent variable) and the high encouragement / TV limits present (high/present) parent behavioural group (independent variable) are the reference groups as they equate to more healthier behaviours compared to their respective groups.

Results

Physical Activity and TV Viewing Descriptives

As shown in Table 26, over half of the sample (52%) watched television on at least four school days, while few students (5.3%) never watched television on a school day. On the most recent school day participants watched television; the majority of participants (64%) watched more than the recommended daily maximum of 2-hours (American Academy of Pediatrics, 2001). A large proportion of the sample (43.7%) were not deemed regularly active during the after school period.

Table 26: Percentage of Participants Engaging in Various Levels of After-School Activity and Weekday TV Use

Variable	Total Sample (n=3,471)	Males (n=1,651)	Females (n=1,820)
Number of days active* after school			
0	16.5	14.2	18.5
1	9.3	8.3	10.2
2	17.9	17.1	18.7
3	19.4	19.1	19.7
4	12.6	13.9	11.5
5	24.3	27.4	21.5
Number of school days watched TV			
0	5.3	4.8	5.8
1	9.4	7.8	10.8
2	15.2	15.0	15.3
3	18.1	18.9	17.3
4	9.5	9.5	9.6
5	42.6	44.0	41.4
TV hours on last day viewed TV			
<1hr	19.8	18.8	20.6
1hr	16.6	15.8	17.3
2hrs	24.9	26.4	23.5
3hrs	16.0	16.4	15.7
4hrs	6.7	6.8	6.7
4+hrs	16.1	15.9	16.2

Television Watching - After-School Physical Activity Association

Television use was found to be related to physical activity during the after-school period. Compared to students who watched less than one hour of TV, participants who watched more than one hour were less likely to be active after school, with those who watched four or more hours of TV being half as likely to be active after-school (Table 27). Furthermore, those who watched TV on more than four days were more likely to be classified as ‘low active’ during the after-school time period.

Table 27: Adjusted Odds Ratio between Physical Activity and TV Use during the After-School Period

Television Use	n	% Active ^a	AOR (95%CI) ^b
No. of school days watched TV*			
0-3 days	1,662	60.5	1.0
4-5 days	1,809	52.5	0.72 (0.63-0.83)
Screen use (hrs on last day TV was watched)*			
<1hr	686	64.0	1.0
1hr	575	57.0	0.77 (0.61-0.98)
2hrs	863	55.9	0.71 (0.58-0.87)
3hrs	556	55.8	0.71 (0.57-0.89)
4hrs	234	53.4	0.64 (0.47-0.86)
4 ⁺ hrs	557	48.7	0.51 (0.40-0.65)

^a Participated in sport, dance, cultural performances, or played active games after school on at least 3 weekdays

^b Adjusted for age, sex, and ethnicity and corrected for cluster effect

* <0.001

Parental Practices and Youth Activity Behaviours

As expected, compared to HTV-LA, HTV-A, and LTV-LA behavioural groups, more youth in the LTV-A have parents who provide both health promoting strategies (encouragement to be active and use of TV limits) and few parents that do not provide either parental strategy (i.e., low encouragement/ TV rules absent) compared to LTV-A youth (Table 28).

Table 28: Percentage of Students by Level of Parental Strategies and Student TV/Physical Activity Behaviour

Parental Strategies	Youth Behavioural Groups Level of TV Use/Activity Level			
	HTV/ LA ^a (n=1,022)	HTV/A ^b (n=1,188)	LTV/LA ^c (n=494)	LTV/A ^d (n=767)
Level of encouragement / TV limits				
High / Present	24.5	40.4	28.1	44.7
High / Absent	20.5	27.4	22.5	26.7
Low / Present	22.1	16.5	26.1	14.3
Low / Absent	33.0	15.7	23.3	14.2

^a High TV and less active

^b High TV and active

^c Low TV and low active

^d Low TV and active

Nominal logistic analyses revealed parental behaviours were significantly ($P < 0.0001$) related to youth behaviour (Table 29). In general, compared to the LTV-A group, youth in all other behavioural groups were at least 28% more likely to have parents that provide only one type of parental strategy (high

encouragement or TV limits) and up to 4.7 times more likely to have parents that don't provide any strategy examined. Hence, a sequential increase in the risk of having parents that provide one strategy compared to no strategy exists for youth in HTV-LA, HTV-A, and LTV-LA compared to their LTV-A peers.

Table 29: Association between Parental Strategies and Child's Activity Behaviours

Parental strategies	Youth Behavioural Groups		
	Level of TV Use/Activity Level		
	HTV/ LA ^a vs LTV/ A ^d OR (95%CI) ^e	HTV/A ^b vs LTV/A ^d OR (95%CI) ^e	LTV/LA ^c vs LTV/A ^d OR (95%CI) ^e
Level of encouragement / TV limits*			
High / present	1.0	1.0	1.0
High / absent	1.51 (1.16-1.96)	1.42 (1.09-1.86)	1.28 (1.01-1.61)
Low / present	2.66 (1.98-3.58)	1.30 (0.98-1.73)	2.40 (1.88-3.06)
Low / absent	4.77 (3.63-6.29)	1.67 (1.23-2.27)	2.56 (1.96-3.34)

^a High TV and less active

^b High TV and active

^c Low TV and low active

^d Low TV and active

^e Corrected for cluster effect and controlled for age group, sex and ethnicity

* <0.001

Discussion

The after-school period is one that provides young people with the option to be either sedentary or physically active. As expected, the majority of high school students in this sample exceeded the recommended maximum of two hours per day screen-time with their TV habits alone, and a large proportion were not regularly active during the after-school period. In line with prior research examining the TV-physical activity link during specific time periods (Hager, 2006), our data supported the displacement hypothesis as the frequency of being active after school was found to be significantly (and inversely) related to both frequency of, and time spent, watching TV during the school week. Hence, because of the limited duration of time between the end of the school day and dinnertime, TV competes with more active pursuits during this period, directing many young people away from more active alternatives.

Similar to prior physical activity (Anderssen & Wold, 1992; Cleland et al., 2005; Davison, 2004; Gottlieb & Chen, 1985; Hoefler et al., 2001; Lau et

al., 1990; McGuire et al., 2002; Neumark-Stzainer et al., 2003; Ornelas et al., 2007; Sallis et al., 1999; Springer et al., 2006; Trost et al., 2003) and TV viewing (Gorely et al., 2004; Norman et al., 2005) focused research, parental behaviours were found to influence activity behaviours during the after-school period. Overall, teenagers who displayed desirable behaviours (low TV use *and* regularly active) during the after-school period were more likely to have parents who demonstrated positive parental behaviours (encouragement to be active *and/or* TV use restrictions). The data in this chapter also indicated that parents who implement several strategies are more likely to be successful in helping their child to be regularly active and spend less time watching TV. Furthermore, the likelihood of youth displaying high TV use and low activity was greater among those with parents who displayed neither parental strategy compared to youth whose parent(s) provided a single strategy (encouragement or TV limits). Based on these data, the presence of parental behaviours has a cumulative effect in teenagers' behaviours.

While the data provided support for the displacement hypothesis and highlighted the importance of utilising multiple parental strategies to assist youth to display desired behaviours (low TV use and regularly active), the limitations of this study need to be recognised. This study was cross-sectional in design inhibiting the ability to infer causation. The design, however, allowed the intention of this study to be achieved. The use of purposive sampling to over-sample Pacific Island youth with low socioeconomic status (while meeting the goals of the OPIC project) did result in a unique sample. As a consequence, the ability to generalise the findings to the New Zealand youth population is limited. Although the sample composition is similar to that of the New Zealand high school population for gender (approximately 50% females), the sample differed substantially by ethnicity (57% Pacific Island, 20% Māori, 12% European, and 11% Asian and Other compared to 7.6%, 24.5%, 62.4% and 5.0%, respectively, for the New Zealand child population aged < 15 years old).

Misclassification of activity level may have arisen from the use of self-report. To counteract this occurring, the questionnaire chosen incorporated previously recommended approaches (Baranowski, 1988); a short monitoring frame (one week) and the use of a segmented day approach.

While alternative instruments (e.g., accelerometers) could provide more objective and accurate indication of the intensity and duration of activity undertaken during the after-school period, pragmatic issues (e.g., cost) inhibited their use in this study. Other issues (i.e., space available in the OPIC survey, limited question-based survey examining after-school physical activity) also restricted the quantity of questions employed. The use of a single perceived encouragement question may not have accurately captured the complexity of perceived encouragement. In particular, perceived encouragement may have been interpreted solely as verbal encouragement, thereby potentially excluding other forms of encouragement (e.g., logistical support). The TV rule question was specifically developed for the OPIC project. Although face validity was examined and the item identified the presence of, and level of strictness associated with, home based TV rules, the item did not capture different types of TV rules (e.g., time restrictions, restrictions on specific programs). The type of rule, however, may also influence the level of engagement in active or non-active pursuits by youth. Finally, we did not measure all forms of sedentary behaviour. Our objective was to focus on TV use as this is a key sedentary behaviour undertaken by youth, one that is accessible in most homes, and is frequently theorised to impact on physical activity.

To increase the study's external validity, replication of the findings within a representative sample of high school students using objective physical activity measures is required. Also, to determine the optimal number of or most influential parental strategies that achieve increased physical activity and reduced sedentary behaviour among youth would require examination of other parental strategies of interest (e.g., logistical support).

Overall, the findings indicated that sedentary behaviours, such as television watching, can displace time away from more active pursuits during the after-school time period. Also, parents are still key influencers of high school students' after-school behaviours, and exert a strong influence, especially if multiple, positive parental strategies are implemented.

Chapter 11: Discussion

Overview of the Projects

At conception of this thesis, the current international literature clearly illustrated low physical activity levels among youth and that these levels declined during adolescence. Additionally, only a developing knowledge of the determinants of physical activity in this age group existed. At the same time, national strategies in New Zealand highlighted young people as a population group at risk of poor health behaviours (Ministry of Health, 2003a), yet, physical activity knowledge specific to the youth population in New Zealand was substantially lacking.

To provide important knowledge, gaining an insight into the patterns and correlates of physical activity among youth in New Zealand became the overarching aim of this thesis. To achieve this aim, three separate, but related, projects were undertaken with participants recruited from various low decile secondary schools in the greater Auckland region. The collected data formed the foundation of the five studies represented in this thesis as individual chapters (Chapters 6 through 10). These chapters cover data on pedometer-determined physical activity levels (Chapter 6), physical activity levels during specific segments of a school day (Chapter 7), patterns of active transportation to/from school (Chapters 6 and 7), weekday TV watching patterns (Chapter 10), as well as individual and environmental influences of activity (Chapters 6 to 10). Collectively, the information contained in the five studies can be delineated into data regarding 'physical activity patterns' and 'correlates of physical activity'.

Physical Activity Patterns

Reported Findings

Using a combination of subjective and objective measurement tools, Chapters 6, 7, and 10 provided important information about the activity habits of high school students. Key findings that build upon existing evidence are noted below.

1. Daily steps values fell within, but at the lower end of, the daily step range for youth noted in earlier international research. Hence, New Zealand youth are potentially less active compared to their international peers.
2. Few students accumulated 10,000 steps daily.

3. Low physical activity engagement on school days was prevalent, especially during segments that existed within school hours (morning recess and lunchtime) compared with out-of-school hours (ATS, after-school physical activity).
4. Less than one-fifth of the students were active across all segments of the school day.
5. Television viewing outside school hours was a frequent weekday activity for most students, while only 5% of students never watched TV on a school day.
6. Based solely on their TV viewing habits (and not all screen-use technology), most participants exceeded the two hour per day screen-use recommendation.

Contribution to Existing Literature

The aforementioned findings are of value to the New Zealand community for several reasons. In recent years, objective instruments (e.g., pedometers) have become popular and preferred methods for assessing free-living physical activity. At conception of this thesis, no New Zealand studies and few international studies had assessed youth activity using pedometers. Evidence in Chapter 6, therefore, is the first published New Zealand-based study on objectively-determined physical activity levels across all age groups represented at New Zealand high school. The pedometer data contained in this thesis adds to the sparse pedometer data available, not only in New Zealand, but also globally. Another important contribution of this thesis is that instead of assessing one context, time, location or intensity specific physical activity, physical activity levels across several segments of a school day were examined among the same sample. Consequently, the question 'are youth maximising the use of opportunistic time periods available during a school day to be active?' could be examined. Lastly, the data adds to the dearth of evidence regarding the active transportation habits to and from school and TV behaviours of New Zealand high school students.

Practical Implications

Collectively, the reported findings highlight that this sample of low socioeconomic positioned youth are not maximising all school day opportunities

to engage in physical activity. Moreover, few students accumulated 10,000 steps daily. The 10,000-step per day level is considered a modest criterion for youth to achieve. It is a level advocated for adults and is a threshold unlikely to be achieved during adulthood by these youth with the expected decline in physical activity that is typically observed during adolescence. The noted low levels of physical activity engagement combined with high TV use highlights public health urgency for interventions that have improved youth physical activity level and reduced time in sedentary pastimes as the key outcomes.

Although literature (Duncan et al., 2008; Duncan et al., 2006; Klasson-Heggebo & Anderssen, 2003; Trost et al., 2000) and findings noted in Chapter 6 showed lower levels of physical activity engagement on weekend days than weekdays, findings reported in Chapter 7 clearly highlight substantial need, and opportunity, to develop interventions to increase physical activity during different segments of a school day. Recess, lunchtime, the after-school period, and active transportation to and from school are all salient opportunities future physical activity strategies could target to assist young people to increase their overall weekly physical activity level. Through targeted school-day interventions, there is potential for New Zealand high school students to accrue a large portion of the daily activity dose, like the accumulated levels noticed among children (Ridgers et al., 2005). While low activity was prevalent across all school day opportunities examined, future studies will need to determine the relative contribution various context-specific activities or individual school day segments make to daily activity levels. Such knowledge may help prioritise which segments or contexts to target in the future.

Targeting school day behaviours is inherently rational for several reasons. Most youth are reachable through the school environment; more structure and potentially more effectual interventions can be delivered through the school system; and such interventions may achieve greater reach to students at risk of low activity outside the school environment. Further thought is required to identify the specific strategies required that best meets the needs of the target group. At a school level, interventions should be based on a comprehensive needs-analysis to identify school-specific strategies. At a community level, whole-community approaches where students, families, the school, and wider community interact collaboratively to increase school day physical activity. At a macro-level, it is unlikely that interventions will succeed,

let alone occur, without significant investment from Government. Although schools are often perceived as an ideal environment in which to implement initiatives by academics, it would be naive to think that school-based interventions alone will improve activity profiles of youth and future adults. With the growing awareness of poor health among youth along with the continual burden placed on schools to develop students holistically with limited resources, strategies wider than the school environment are advocated.

Correlates of Physical Activity

Reported Findings

To extend current international literature and address the scarcity of correlate-based research in New Zealand, quantitative and qualitative methodologies were employed to identify potential correlates of activity among youth in New Zealand.

In recent years, active transportation to/from school has been promoted as a key domain through which students can obtain part of their daily activity dose. Consistent with international literature on children, New Zealand high school students who commuted actively to school achieved significantly greater daily step counts than car transit users. Whether this step differential existed because of variations in commuting behaviour alone could not be determined, because other potential contributors (e.g., sport participation) were not accounted for. Moreover, commuting behaviour differed substantially between schools, with more students at public/zoned schools commuting actively than students at nonzoned schools.

Using qualitative methodology, focus groups were conducted to elucidate the perceptions youth hold about physical activity (Chapter 8). While not providing a representative picture of New Zealand youth views, focus groups provide the opportunity to employ a youth-centred approach and collect rich information. Participants clearly articulated that physical activity, while socially rewarding, was not always a high priority, especially not over recreational sedentary alternatives (e.g., TV watching). Barriers to being active across various physical activity domains were primarily environment-related, with young people voicing that their immediate environments (e.g., friends, school, home, neighbourhood) promote sedentary behaviour and make healthy choices difficult. Key barriers were reflected in the physical activity promoting strategies

verbalised, including but not restricted to: increasing social support from peers; improving availability of, and accessibility to, activities at school and in their neighbourhood; parent intervention (e.g., turning off the TV); providing organised activities at school; and restructuring physical education classes to allow student involvement in the decision-making process of class content. Although groups were separated by sex and ethnicity (Māori and European), only few sex and no ethnic differences were noted. Because all participants attended low decile schools, the commonality of their socioeconomic status (based on school decile rating) likely supported the congruence of perceptions between the ethnic groups.

In light of the social issues highlighted in Chapter 8, the link between perceived encouragement and physical activity was examined in Chapter 9 using an ecological framework. It was hypothesised that the most proximal influencers (e.g., parents, friends) to the time-specific physical activity being assessed (e.g., active transportation, lunchtime activity) would exert the strongest influence. Consistent with ecological theory and the noted hypothesis, the relative importance of encouragement from various sources (i.e., friends, parents, older siblings/cousins, schools) was found to be dependent on the physical activity examined. Consistent across age groups (junior and senior students), peer encouragement was a key influence of activity during lunchtime, while both parent and peer encouragement influenced frequency of after-school activity. Encouragement from older siblings was also associated with after-school activity, but for junior students only. Encouragement from parents and schools influenced the active transportation patterns to/from school of junior students; active transportation to/from school among senior students was not influenced by any of the sources examined. Contradicting common perceptions that during adolescence friends override parents as powerful influencers, friends as well as parents were found to be key social influencers for both junior and senior students. A key finding was that parental structure (single versus dual parent households) did not change the likelihood of youth being active, as long as they received high support from at least one parent. The underlying theme is that when devising interventions, proximal social networks need to be considered.

Based on findings from the prior Chapters, the relationships between weekday TV viewing habits, after-school physical activity levels, and parental

strategies (i.e., encouragement to be active, enforcing TV rules) were examined in Chapter 10. Support for the displacement hypothesis was found. In particular, increased TV viewing (daily duration and weekly frequency) reduced the likelihood of youth being regularly active during the after-school period. Parental strategies positively influenced youth activity profiles (based on TV and PA habits), and that the existence of parental behaviours had a cumulative effect on young peoples' behaviour. In particular, parents exhibiting only one strategy increased the risk that their child self-reporting undesirable behaviours (high TV use *and* low activity), with the risk increasing further for parents who did not exhibit any strategy.

Contribution to Existing Literature

The findings in this thesis add to current New Zealand evidence and international literature regarding social-related environmental correlates of activity in several ways. First, while qualitative work of perceived benefits of, and barriers to, physical activity have been examined previously, the examination of youth perceptions of domain, context, or location-specific activities (with the exception of physical education), and potential youth identified strategies has rarely been conducted. Second, parents and friends have been the primary social networks examined while other potential sources of support that exist within young people's immediate environment have been overlooked. Third, earlier social support studies have been limited by assessing predominantly global physical activity levels or intensity-based activity (e.g., MVPA) without considering the differential impact support sources may have across different context-, or location-specific activities as implied by ecological theory. Fourth, the 'displacement hypothesis' has been examined extensively, but typically in terms of weekly physical activity levels. In consequence, the potential to determine the true association between physical activity and sedentary behaviour is diluted because sufficient time is available during a week to be both active and also highly sedentary. Instead of assessing total physical activity, examining activity during periods where time is limited and when youth must choose to engage in either an active or sedentary pastime (e.g., during the after-school time period) may elucidate the importance of the sedentary-physical activity link. Fifth, prior to this thesis, little was known about the impact of home TV policies or the cumulative effect parental practices have

on young people's activity patterns (physical activity and sedentary behaviours), or the effect different parental structures (single parent, dual parents, or no parents) have on physical activity participation.

Practical Implications

Although well known, the findings provide further support for the premise that youth activity is influenced by a multitude of influences and influencers. A multi-strategy, multi-environment, coordinated approach that addresses the reported policy, physical, economic, and social correlates of specific physical activity domains is therefore required to improve youth activity behaviours.

Active transportation is one physical activity domain in which New Zealand youth can accumulate a good part of their daily activity dose, habitually. This domain, therefore, should be targeted in future initiatives. How to achieve an increase in active transportation requires further examination. The differences noted in active transportation levels between zoned and nonzoned schools (Chapter 6) highlights the impact that Government-level policy decisions (e.g., school zoning regulations) can have on behaviours, even behaviours not directly (or consciously) targeted. From a physical activity perspective, zoning-related policies appear to be beneficial in assisting young people engage in active transportation. Within the wider context, there is still much debate around the pros and cons (e.g., in terms of ethnic and income polarisation, freedom of choice, and equity) of school zoning regulations (LaRocque, 2005) that need consideration. In the unlikely situation of school zoning regulations being applied across all schools, school specific strategies are required. Considering the substantial difference in active transportation levels across schools, future strategies targeting increased active transportation need to consider contextual factors and the needs of individual schools. As expected, the literature clearly indicates that active commuting to and from school to be influenced by various physical (e.g., distance), social (e.g., perceived safety), economic (e.g., SES), and policy (e.g., parental rules) factors. It is too simplistic to believe that any one strategy will be effective in modifying active transportation behaviours; therefore, a broader ecological approach to developing interventions is necessary.

In addition to policy-related strategies, social networks should be considered, especially those most proximal to the physical activity domain being

targeted. Instead of identifying and targeting one support source as having the greatest influence on youth physical activity, Chapters 9 and 10 clearly indicate that both friends and family have a role in encouraging youth to be active, it just depends on the physical activity domain being promoted. Also, building on the positive and cumulative effect parental strategies had on youth activity profiles (i.e., TV and after-school physical activity habits), determining the optimal number, and types, of parental strategies would be beneficial information for current and future parents.

In contrast to the findings of much previous research, this thesis supports the displacement hypothesis during daily segments where time is limited and young people need to make a choice between coexisting active and sedentary pastimes. While TV viewing may have a weak relationship with weekly physical activity levels, it was associated with after-school physical activity habits in this thesis. A one size fits all approach to improve activity levels is inadequate and specific strategies need to be developed according to the physical activity domain or context being targeted. If after-school activity is the targeted behaviour, reducing time engaged with screen-based technology may translate into youth engaging in more active pursuits, especially if the environment supports this shift.

Lastly, the perceptions of physical activity, from which interventions can be based, appear to be consistent across Māori and European ethnic groups that reside within similar low socioeconomic status areas. Future interventions, therefore, need to target the underlying issues that prevent youth from low socioeconomic backgrounds leading an active lifestyle. To strengthen the evidence regarding ethnic differences (or lack thereof), studies should endeavour to include participants that span the various levels of social class. In addition, examining intraethnic differences (e.g., why are some Māori are active and other Māori are not?), may provide additional, unique, and fruitful insights into the cultural issues associated with health behaviours, such as physical activity.

Methodological Limitations

The aforementioned results and practical implications inferred, while adding to current knowledge of youth physical activity, need to be considered in light of the methodological caveats. The main limitations relate to sampling,

measurement, and study design issues that transpired from pragmatic constraints.

Sample

As this thesis was part of a larger intervention project (i.e., OPIC project) focusing on low socioeconomic positioned students, a representative New Zealand sample was not sought for the research in this thesis. Although convenience sampling is not the gold standard, the sample size and sampling methods we employed are in line with published studies assessing children and youth physical activity using pedometers. Despite this level of congruence with similar international research, the study designs preclude the generalisability of the findings to the New Zealand youth population. Consequently, the findings must be interpreted with relevant caution. Replication of the studies using a large representative sample of high school students is required to increase the external validity of the reported findings to the youth population.

Measurement

Measurement is an inherent challenge in physical activity research. While pedometers provided the much needed objectivity, strict adherence with pedometer wearing instructions is essential for the collection of robust and complete data. Although studies on children report low exclusion rates, this is not so for youth-related studies. The pedometer findings reported in this thesis are hampered by a large exclusion rate resulting from incomplete data. An outcome explained, in part, by the following reasons. The use of a seven-day-memory pedometer negated the need to record step counts on a daily basis. While minimising participant and researcher burden, the prompt to wear the pedometer that daily recording may have provided was eliminated. Compared to primary schools, the structure of high schools did not allow either standardised pedometer distribution procedures (e.g., duration to distribute, location of distribution), or did it allow consistent daily prompting from a single teacher. Lastly, the novelty of the pedometer may have worn off overtime and, therefore, participants chose not to wear it.

To improve compliance and, in turn, reduce the exclusion of data, verbal (e.g., phone calls, prompts from teachers), visual (e.g., text messaging, posters, stickers, fridge magnets) and behavioural (e.g., completing pedometer logs)

prompts could be incorporated into future research designs. In case of pedometer malfunction, the latter prompt also provides a data back-up system. Texting and phone calls may result in substantial researcher burden, and may pragmatically be impossible for a single researcher to execute – especially as part of a doctoral study. Determining if participants comply with wearing instructions is problematic. No method currently provides researchers full assurance of satisfactory compliance. To address compliance in this thesis, at time of pedometer return, students self-reported the amount of time they did not wear the pedometer for each of the previous five days. Requesting this to be conducted each day, may have also aided as a prompt as well as reducing recall bias. As compliance is a methodological issue faced by researchers employing objective measures, it would be useful to know what prompts are the most cost-effective in reducing poor compliance rates.

In addition to pedometers, physical activity participation during different school-day segments was assessed using a self-report questionnaire. While imperfect due to the inherent subjective nature of such tools, surveys have typically been employed to capture physical activity behaviours. Implementing a short monitoring timeframe and using a segmented day approach reduced the potential for recall bias. Questions used were directly replicated from the New Zealand Children's Nutrition Survey. (Parnell et al., 2003) This national survey was based on the Physical Activity Questionnaire for Children, a questionnaire which has demonstrated acceptable reliability and validity (Crocker et al., 1997; Kowalski et al., 1997a; Kowalski et al., 1997b). Although basic validation (e.g., face validity) and comprehension checks of each question was undertaken, the questions were a modified version of the original Physical Activity Questionnaire for Children. Global questions were used to assess lunchtime and recess activity patterns. People who demonstrate high variability in their behaviour day-to-day may have difficulty responding to such question types. A recall diary or time-use diary would overcome this difficulty, but such methods are more time-intensive.

Compared to pedometers and self-report surveys, accelerometers provide an alternative method which collects time and intensity-related data objectively. They are, however, more expensive and do not provide context-related information. A self-report tool (e.g., activity log) would therefore be

necessary to delineate activity counts recorded as a result of active transportation versus nonactive transportation activities.

Perceived encouragement to be active and knowledge of home TV rules were also measured using self-report. Although not ideal, the application of a single generic question to assess frequency of encouragement to be active from different support sources (e.g., mother, father, bother/male cousin, sister/female cousin, friends, school) was chosen for pragmatic reasons. Consequently, the word 'encouragement' may have been interpreted differently between participants (e.g., verbal, physical, logistical encouragement). Similarly, the term 'school encouragement' also needed self-interpretation with respect to the source (e.g., support from head teacher, senior managers/teachers, physical education teachers). Moreover, a single question may not accurately capture the complexity of perceived encouragement. In terms of TV rules, no studies had assessed this potential home policy-related factor. As this is a new question, more stringent validation is required if it is to be incorporated into future studies.

Study Design

A cross-sectional study design underpinned the three projects conducted as part of this thesis. As a consequence, effects of age, period, or generation could not be separated. Thus, while relative age declines across various physical activity domains were noted between senior and junior students, the noted differences may have been attributable to chronological age and/or the time period of the survey. Although extremely expensive, longitudinal cohort study designs are required for causation to be determined and for absolute changes to be determined. Although two longitudinal cohort studies are currently underway in New Zealand - the Pacific Islands Families Study (Paterson et al., 2006) and the Dunedin Multidisciplinary Health and Development Study (Dovey et al., 1998; West, Reeder, Milne, & Poulton, 2002) - they are limited by the sample homogeneity. As New Zealand is a small country, geographically, conducting a longitudinal study on a representative sample of the population is plausible.

Lastly, simple methods were employed to delineate mutually exclusive groups and to analyse the data (e.g., binary logistic regression) of complex

physical activity concepts. Youth activity is obviously influenced by a multitude of factors, people, and environments, which are interwoven and intricate variables. Future research would benefit from incorporating statistical methods which are reflective of, and account for, such complexities. Appropriate mixed models analyses need to be conducted that capture the complexities and interactions of the environments within which physical activity takes place. One such statistical technique is structural equation modelling (SEM), a powerful method which tests models (rather than coefficients individually) and mediating variables, accounts for multiple dependents, interactions, and correlated independents, as well as having the ability to handle difficult data such as time series data and incomplete data (Garson, 2007).

Future Directions

Measurement

Measurement is a challenging aspect of physical activity research. Researchers have a plethora of tools that assess physical activity from which to choose. Cross-study data comparisons are made difficult as the implementation of tools and associated analyses are not directly replicated. Only when standardised protocols are developed, through international consensus, will a truly comprehensive, accurate, and co-ordinated evidence-building approach be possible. While idealistic, pragmatic issues (e.g., funding, sample size differences, geographic considerations, ever-evolving tools) may impact on the potential for a consistent application of measures across countries and studies globally. In New Zealand, the research community is relatively small and therefore has the potential to incorporate a more co-ordinated and collaborative approach to building New Zealand-specific evidence on youth physical activity that would also add to international literature.

Ecological Approach

The findings reported in this thesis provide further support that youth physical activity is shaped by multiple factors. Extending current knowledge, the findings show that, at least for social influences, the degree of influence is very much dependent on the specific context-, location-, or time-specific activity examined. Moving forward, researchers should endeavour to incorporate truly ecological approaches to both determinant and intervention work that considers

all aspects of the environment – physical, social, economic, and policy – at both the micro- and macro-environment levels. Rather than examining each aspect of the environment in isolation, researchers should focus on the associated interactions between physical, social, policy, and economic factors. Such approaches should also be formulated from, and help expand, existing behavioural theory.

Social versus Physical Environment Debate

It would be too simplistic to consider that any one aspect of the environment plays a greater role in shaping the activity behaviours of New Zealand's future youth. While some aspects of the environment (e.g., social) have received greater research attention, all four aspects require equal attention in the future, both from an academic and intervention perspective. In recent years, the ever-growing attention has been directed towards understanding the link between physical activity and characteristics of the physical environment. While the physical environment is a likely contributor to the current state of physical activity globally, retro-fitting the environment to what it once was (e.g., limited sedentary conveniences) will not solve the issue of consumerism which undoubtedly contributes to human's inactivity. As human culture and the expectations of minimum daily living standard have aligned with technological advances, simply modifying the environment will not overcome the perceived convenient lifestyle to which humans have become accustomed. For behaviour change to occur, a truly holistic, dose intensive, intervention is required. Focusing on only one aspect of the environment is likely to fail.

New Zealand Physical Activity Monitoring System for Children and Youth

The findings of this thesis, while adding to current descriptive evidence of physical activity among a sample of New Zealand youth, do not provide a representative picture. A comprehensive understanding of youth physical activity in New Zealand is not possible from available national data because of the fragmented approach undertaken to collect physical activity data to date. Just as there is a robust national monitoring programme for nutritional behaviours in New Zealand, a complete, accurate, and comprehensive monitoring system of physical activity among children and young people needs to be developed and implemented. Such development would benefit a cross-

agency approach because physical activity spans and underpins the work of several New Zealand government agencies.

Sedentary Behaviours

Sedentary behaviour was briefly touched upon in this thesis. This is an emerging but to date largely understudied area of research that deserves greater attention from both research and government communities. Televisions, while remaining the dominant medium of small screen technology (Roberts et al., 1999; Tammelin et al., 2007) are only one marker of sedentariness, and other forms of sedentary behaviour (e.g., sitting) require investigation. This line of investigation is supported by recent findings that sitting may place humans at increase risk of various health conditions, above and beyond that of not engaging in sufficient MVPA (Hamilton, Hamilton, & Zderic, 2007). Considering humans have yet to reach the pinnacle of inactivity, the continual removal of intermittent, incidental physical activity in everyday life combined with lack of targeted intervention may result in significant clinical and public health ramifications in the not so distant future.

Promotion of Physical Activity

At the conception of this thesis, a clear gap in New Zealand for advocating a physically active lifestyle was the lack of up-to-date physical activity guidelines specific to the New Zealand child and youth population. On 7 December 2007, as a combined initiative between SPARC and the Ministries of Health and Education, such guidelines were released. While development and promotion of guidelines alone will be unsuccessful in changing behaviours, the strategies developed to achieve these new guidelines will be crucial. Currently, we live in a world saturated by an assortment of social marketing campaigns informing [aka telling] people what to do in terms of a wide range of health behaviours, including but not restricted to healthy eating, physical activity, anti-smacking, drinking and driving, and anti-smoking. Considering unhealthy habits tend to cluster within certain groups of individuals, the concurrent and continual bombardment of social marketing campaigns will likely lead to desensitisation among the target audience, and potentially dilute the effectiveness of any single campaign. As social marketing is a popular strategy

across government agencies, the impact of multiple social marketing campaigns running concomitantly is warranted.

It is well accepted that knowledge alone is not sufficient for modifying behaviours. In addition to (or even instead of) social marketing campaigns and education-based initiatives, alternative and stealth-like activity promoting strategies need to be conceived. Such strategies may or may not rely on the conscious thoughts of humans. Also, physical activity may be targeted directly or indirectly, with the latter identifying increased physical activity as a potential by-product of the initiative undertaken (e.g., school zoning regulations). Issues of national importance, such as climate change and environmental sustainability, therefore become vehicles through which physical activity can be indirectly promoted. Such an approach may also lead to potential cross-government collaboration, not only across the usual-suspects, but wider government. Being involved with policy regarding urban and suburban development may transpire into more active-friendly environments.

It is likely that public servants will never have the 'best-evidence' upon which to inform future intervention efforts. This lack of evidence should not hinder the development of interventions that are based on 'best-available evidence' and commonsense. While correlate research is of importance, action is needed now to off-set further declines in physical activity and increased sedentary behaviour.

Conclusion

In conclusion, this thesis showed that a large proportion of students from low socioeconomic backgrounds are not maximising all opportunities to be active (especially during school hours and weekends). In addition, most youth exceed the recommended level of daily screen-use with their TV viewing habits alone. Taken collectively, these findings highlight public health urgency for physical activity interventions targeting youth. Because many environments surrounding youth promote sedentariness and inactivity, increasing physical activity is not only an individual problem but a societal one. For improved activity levels to be achieved, future strategy development and intervention work need to be underpinned by a coordinated, multi-strategy, and multi-environment approach that addresses the various policy, physical, and social determinants of youth activity. Substantially more work is required to address the health issues

of physical inactivity and sedentariness. Therefore, both researchers and policy makers should direct equal attention at improving physical activity levels and reducing time youth spend in a sedentary state.

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Appendices

Appendix A: Ethics Approval (Project 1)



MEMORANDUM

Academic Services

To: Grant Schofield
From: **Madeline Banda**
Date: 21 July 2005
Subject: Ethics Application Number 05/89 **Physical activity among youth in New Zealand: prevalence and environmental influences.**

Dear Grant

Thank you for providing written evidence as requested. I am pleased to advise that it satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC) at their meeting on 9 May 2005. Your ethics application is now approved for a period of three years until 21 July 2008.

I advise that as part of the ethics approval process, you are required to submit to AUTEC the following:

- A brief annual progress report indicating compliance with the ethical approval given using form EA2, which is available online through <http://www.aut.ac.nz/research/ethics>, including a request for extension of the approval if the project will not be completed by the above expiry date;
- A brief report on the status of the project using form EA3, which is available online through <http://www.aut.ac.nz/research/ethics>. This report is to be submitted either when the approval expires on 21 July 2008 or on completion of the project, whichever comes sooner;

You are reminded that, as applicant, you are responsible for ensuring that any research undertaken under this approval is carried out within the parameters approved for your application. Any change to the research outside the parameters of this approval must be submitted to AUTEC for approval before that change is implemented.

Please note that AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to make the arrangements necessary to obtain this.

To enable us to provide you with efficient service, we ask that you use the application number and study title in all written and verbal correspondence with us. Should you have any further enquiries regarding this matter, you are welcome to contact Charles Grinter, Ethics Coordinator, by email at charles.grinter@aut.ac.nz or by telephone on 921 9999 at extension 8860.

On behalf of the Committee and myself, I wish you success with your research and look forward to reading about it in your reports.

Yours sincerely

A handwritten signature in black ink, appearing to read 'M. Banda', is written over a light blue horizontal line.

Madeline Banda
Executive Secretary
Auckland University of Technology Ethics Committee

Cc: Maea Tita Emere Hohepa maea.hohepa@aut.ac.nz

From the desk of ...
Madeline Banda
Academic Services
Student Services

Private Bag 92006, Auckland 1020
New Zealand
E-mail: madeline.banda@aut.ac.nz

Tel: 64 9 921 9999
ext 8044
Fax: 64 9 921 9812

Appendix B: Consent Form for School Principals (Project 1)



Consent to Participation in Research School Consent Form

Title of Project: **Physical Activity and New Zealand Youth**
Project Supervisors: **Dr Grant Schofield, Dr Gregory Kolt, Dr Robert Scragg**
Researcher: **Maea Hohepa**

- I have read and understood the information provided about this research project
- I have had an opportunity to ask questions and to have them answered.
- I understand that I may withdraw permission to access the school's students at any time prior to completion of data collection, without being disadvantaged in any way.
- I agree Auckland Seventh Day Adventist High School can take part in this research.
- I wish to receive a copy of the report from the research.

Principal's signature:

Principal's name:

Principal's Contact Details:

.....
.....
.....

Date: 02.10.04

Approved by the Auckland University of Technology Ethics Committee on 21st July 2005 AUTEK
Reference number 05/89

Appendix C: Participant Assent and Parental Consent Form (Project 1)



Consent to Participation in Research Parental Consent & Participant Assent Form

Title of Project: **Physical Activity and New Zealand Youth**
Project Supervisors: **Dr Grant Schofield, Dr Gregory Kolt, Dr Robert Scragg**
Researcher: **Maea Hohepa**

Parental/Caregiver Consent:

- I have read and understood the information provided about this research project
- I have had an opportunity to ask questions and to have them answered.
- I understand that I may withdraw my child or any information that my child has provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
- If I withdraw my child, I understand that all relevant data, or parts thereof, will be destroyed.
- I agree my child can take part in this research.
- I wish to receive a copy of the report from the research.

Name of School Child Attends :

Parent/Guardian signature:

Parent/ Guardian name (Print Clearly):

Parent / Guardian Contact:

Phone No.

Mob. No.....

Email Address:.....

Participant Assent:

- I have read and understood the information provided about this research project
- I have had an opportunity to ask questions and to have them answered.
- I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
- If I withdraw, I understand that all relevant data, or parts thereof, will be destroyed.
- I agree to take part in this research.
- I wish to receive a copy of the report from the research.

Participant signature:

Participant name (Print Clearly):

Approved by the Auckland University of Technology Ethics Committee on 21st July 2005 AUTEK
Reference number 05/89

Appendix D: Consent Form for Participants ≥ 16 years old (Project 1)



Consent to Participation in Research Participant Consent Form

Title of Project: **Physical Activity and New Zealand Youth**
Project Supervisors: **Dr Grant Schofield, Dr Gregory Kolt, Dr Robert Scragg**
Researcher: **Maea Hohepa**

- I have read and understood the information provided about this research project
- I have had an opportunity to ask questions and to have them answered.
- I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
- If I withdraw, I understand that all relevant data, or parts thereof, will be destroyed.
- I agree to take part in this research.
- I wish to receive a copy of the report from the research.

Participant signature:

Participant name:

Name of School Participant Attends :

Participant Contact Details

Phone No.

Mob. No.....

Email Address:.....

Date:

Approved by the Auckland University of Technology Ethics Committee on 21st July 2005 AUTEK
Reference number 05/89

Appendix E: Information Sheet for School Principals (Project 1)



School Information Sheet

Physical Activity and New Zealand Youth



My name is Maea Hohepa. Under the supervision of Dr Grant Schofield and in conjunction with the OPIC study, I am undertaking this project to examine physical activity levels of youth in New Zealand and what factors influence young people to be active or not. This study is part of my PhD studies at Auckland University of Technology and will contribute to the intervention aspect of the OPIC study. I would like to invite your school to participate in this project.

Below is some information about the aim of the project and what the project involves.

What is the project about?

- By approaching students in a small number of form classes from your school, the aim of this study is to measure their activity levels using an objective measurement tool (e.g., pedometer) and to examine environmental factors that influence their level of activity.

What will happen with the information?

- The information will be included in Maea's PhD research.
- The information gained will be used in conjunction with the OPIC project being led by the University of Auckland, and will contribute to the intervention aspect of the OPIC study.

What do the participants have to do?

- During form class each participant will be given a pedometer to wear for 5 days (3 week days plus the weekend).
- A pedometer is a small device that measures a person's level of physical activity. It attaches to a person's trousers or skirt.
- After 5 days, Maea Hohepa will return to the form class to collect the pedometer and the participants will complete a short questionnaire. The questionnaire includes questions about what factors influence activity levels of young people.
- At this time each participant will also complete a compliance form, which asks how frequently the pedometer was worn over the previous five days.

Anonymity and Confidentiality

- All information is confidential.
- At no time will information be published that would identify a participant.
- The researchers involved in the study will be the only people with access to the research data.
- No individual outside the research team will have access to the information.
- All data and consent forms will be stored in a locked room with limited access on the premises of Auckland University of Technology. After ten years hard copies of the data/consent forms will be shredded. Computerised copies of the data will be erased.

Why be involved?

- Each participant will receive a personalised feedback form regarding his or her level of physical activity.
- Also, participants will be part of a study that aims to gain information to help the development of interventions promoting a healthier lifestyle.
- After the research is completed a fact sheet stating the main findings of the study will be disseminated to the schools involved.

What do students have to do to participate?

- For students to participate in the study the following form needs to be signed.
 1. Participant assent/consent form
 2. Parental consent form for students under the age of 16 years.

Where to return the consent form

- Students will be given an envelope to place the signed consent form(s) inside which will be returned to the student's form class teacher.
- Maea Hohepa will collect the participant consent form during form class.

Consent to participate

- Participation in this study is completely voluntary and participants are free to withdraw consent and withdraw any information traceable to them and discontinue participation at any time without giving a reason before data collection is completed.

School Consent to Participate

- Giving consent on behalf of the school indicates you agree to give Maea Hohepa permission to address the students of your school about the study and send information sheets and consent forms home with students who are potential participants.
- Signing and dating the school consent form indicates that you have freely given consent to participate, and that there has been no coercion or inducement to participate.

Do You Have Any Questions About the Research?

If you have any questions about the study, please do not hesitate to contact one of the researchers.

Researcher - Contact Details:

Maea Hohepa
Division of Sport and Recreation
Faculty of health
Auckland University of Technology
Private Bag 92006
Auckland.
Tel: (09) 921-9999 ext 7848
E-mail maea.hohepa@aut.ac.nz

Project Supervisors - Contact Details:

Assoc Prof Grant Schofield
Division of Sport and Recreation
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E-mail: gregory.kolt@aut.ac.nz

Do You Have Any Concerns?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor. Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEK, Madeline Banda, madeline.banda@aut.ac.nz, 921 9999 ext 8044.

**Approved by the Auckland University of Technology Ethics Committee on 21st July 2005 AUTEK
Reference number 05/89**

Appendix F: Information Sheet for Parents of Participants < 16 years old (Project 1)



Parent and Participant Information Sheet

Physical Activity and New Zealand Youth

My name is Maea Hohepa. Under the supervision of Dr Grant Schofield, I am undertaking this project to examine physical activity levels of youth in New Zealand and what factors influence young people to be active or not. This study is part of my PhD studies at Auckland University of Technology. I would like to invite your child to participate in this project.

Below is some information about the aim of the project and what the project involves.

What is the project about?

The aim of this project is to understand how active high school students are and the factors that influence their level of activity.

What do the participants have to do?

- During form class each participant will be given a pedometer to wear for 5 days.
- A pedometer is a small device that measures your level of physical activity. It attaches to a person's trousers or skirt.
- After 5 days, Maea Hohepa will return to the form class to collect the pedometer. At this time each participant will complete a compliance form, which asks how frequently the pedometer was worn. A short questionnaire will also be completed. The questionnaire includes questions about what factors influence activity levels of young people.

What will happen with the information?

- The information will be included in Maea's PhD research.
- The results of the study will also help inform the development of initiatives promoting a healthier lifestyle.
- The information gained will be used in conjunction with the obesity prevention project called 'Living for Life' that is being led by the University of Auckland.

Anonymity and Confidentiality

- All information is confidential.
- At no time will information be published that would identify a participant.
- The researchers involved in the study will be the only people with access to the research data.
- No individual outside the research team will have access to your information.
- All data and consent forms will be stored in a locked room with limited access on the premises of Auckland University of Technology. After ten years hard copies of the data/consent forms will be shredded. Computerised copies of the data will be erased.

Why be involved

- Each participant will receive a personalised feedback form regarding his or her level of physical activity.
- Also, participants will be part of a study that aims to gain information to help the development of interventions for the 'Living for Life' project that is being conducted in Mangere.
- After the research is completed the participant's school and family will receive a fact sheet stating the main findings of the study.

What do you have to do to participate?

For your child to participate in the study the following form needs to be signed.

1. Participant assent and parental consent form (the yellow form)

A parent/caregiver's signature is required for participants under the age of 16 years.

Where to return the consent form

- Place the form in the envelope provided and return to your child's form class teacher.
- Maea Hohepa will collect the participant consent form during form class.

Consent to participate

Participation in this study is completely voluntary and you and your child are free to withdraw consent and withdraw any information traceable to your child and discontinue participation at any time without giving a reason before data collection is completed.

Do You Have Any Questions About the Research?

If you have any questions about the study, please do not hesitate to contact one of the researchers.

Researcher Contact - Details:

Maea Hohepa
Division of Sport and Recreation
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Project Supervisors - Contact Details:

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Do You Have Any Concerns?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor. Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEK, Madeline Banda, madeline.banda@aut.ac.nz, 917 9999 ext 8044.

Approved by the Auckland University of Technology Ethics Committee on 21st July 2005 AUTEK
Reference number 05/89

Appendix G: Information Sheet for Participants (Project 1)



Participant Information Sheet

Physical Activity and New Zealand Youth

My name is Maea Hohepa. Under the supervision of Dr Grant Schofield, I am undertaking this project to examine physical activity levels of youth in New Zealand and what factors influence young people to be active or not. This study is part of my PhD studies at Auckland University of Technology. I would like to invite you to participate in this project.

Below is some information about the aim of the project and what the project involves.

What is the project about?

- The aim of this project is to understand how active high school students are and the factors that influence their level of activity.

What do the participants have to do?

- During your form class you will be given a pedometer to wear for 5 days.
- A pedometer is a small device that measures your level of physical activity. It attaches to a person's trousers or skirt.
- After 5 days, Maea Hohepa will return to your form class to collect the pedometer. At this time you will complete a compliance form, which asks you how frequently you wore the pedometer. You will also complete a short questionnaire. The questionnaire includes questions about what factors influence your activity level.

What will happen with the information?

- The information will be included in Maea's PhD research.
- The results of the study will also help inform the development of initiatives promoting a healthier lifestyle.
- The information gained will be used in conjunction with the obesity prevention project called 'Living for Life' that is being led by the University of Auckland.

Anonymity and Confidentiality

- All information is confidential.
- At no time will information be published that would identify a participant.
- The researchers involved in the study will be the only people with access to the research data.
- No individual outside the research team will have access to your information.
- All data and consent forms will be stored in a locked room with limited access on the premises of Auckland University of Technology. After ten years hard copies of the data/consent forms will be shredded. Computerised copies of the data will be erased.

Why be involved

- Each participant will receive a personalised feedback form regarding his or her level of physical activity.
- Also, participants will be part of a study that aims to gain information to help the development of interventions for the 'Living for Life' project that is being conducted in Mangere.
- After the research is completed the participant's school and family will receive a fact sheet stating the main findings of the study.

What do you have to do to participate?

- To participate in the study you are required to
 1. Sign a participant consent form.

Where to return the consent form

- Maea Hohepa will collect the participant consent form during form class.

Consent to participate

- Participation in this study is completely voluntary and you are free to withdraw consent and withdraw any information traceable to you and discontinue participation at any time without giving a reason before data collection is completed.

Do You Have Any Questions About the Research?

If you have any questions about the study, please do not hesitate to contact one of the researchers.

Researcher - Contact Details:

Maea Hohepa
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Do You Have Any Concerns?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor. Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEK, Madeline Banda, madeline.banda@aut.ac.nz, 917 9999 ext 8044.

**Approved by the Auckland University of Technology Ethics Committee on 21st July 2005 AUTEK
Reference number 05/89**

Q11: During a typical week how often do your PARENT(S)	Never	Once	Sometimes	Almost daily	Daily
Encourage you to do physical activity or play sports?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do a physical activity or play sports with you?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Provide transportation to a place where you can do physical activities or play sports?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Watch you participate in physical activities or sport?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q12a: Are the following items or pets available in your home ..	If YES, tick the circle	Q12b: If you do have the item at home HOW OFTEN do you use the items to be physically active?	Less than once per week	1 –2 times per week	3 – 4 times per week	5 – 6 times per week	Daily
Your family dog	<input type="radio"/>	Your family dog	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Trampoline	<input type="radio"/>	Trampoline	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your backyard	<input type="radio"/>	Your backyard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Running / walking shoes	<input type="radio"/>	Running / walking shoes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Weight lifting equipment	<input type="radio"/>	Weight lifting equipment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sporting equipment (balls, racquets, frisbee)	<input type="radio"/>	Sporting equipment (balls, racquets, frisbee)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Surf boards, boogie boards	<input type="radio"/>	Surf boards, boogie boards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bicycle that is in working order	<input type="radio"/>	Bicycle that is in working order	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Basketball hoop	<input type="radio"/>	Basketball hoop	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Scooter (non-motorised)	<input type="radio"/>	Scooter (non-motorised)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Exercise videos	<input type="radio"/>	Exercise videos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Radio or stereo	<input type="radio"/>	Radio or stereo	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

SECTION 5: QUESTIONS ABOUT INCREASING PHYSICAL ACTIVITY LEVEL

Q13: I would be more active at school if...	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
I could have better access to the sports equipment during breaktimes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I could have better access to the school gym	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There were fun organised physical activities straight after school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If physical activities that I would like to do were organised at lunchtime	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If other physical activities or sports I would like to do were introduced at my school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If there were more sport teams for the different sports	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If I didn't have to trial for a sports team	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q14: I would be more active if my parents...					
Helped me join a sport/activity group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Took me to places to be more active	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gave me more encouragement to be active	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Did physical activities with me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q15: I would be more active if my friends...					
Were more active with me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Joined sports teams and clubs with me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q16: I would walk or bike to school more often if ...					
My friends would walk or bike with me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

SECTION 2: QUESTIONS ABOUT YOUR SCHOOL

Q17: How much do you agree with the following statements about your school?	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
The gym space allows me to do all the activities I want	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PE classes make physical activity and sports more appealing to participate in	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The sport or exercise equipment at school works well	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am allowed to use sports equipment at lunchtime	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is easy for me to access the school's sports equipment during lunchtime	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is easy for me to access the gym during lunchtime	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The school's facilities makes it easy for me to be active even when it rains	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Thank you for completing this survey

Appendix I: Ethics Approval (Project 2)

MEMORANDUM



Student Services Group – Academic Services

To: Grant Schofield
From: Madeline Banda
Date: 29 April 2004
Subject: 04/68 Nga Tirohanga o Te Whakapakari Tinana, Te Kai Totika me Te Momonatanga.
Perceptions of physical activity, healthy eating, and obesity

Dear Grant

Thank you for providing amendment and clarification of your ethics application as requested by AUTEK.

Your application was approved for a period of two years until 29 April 2006.

You are required to submit the following to AUTEK:

- A brief annual progress report indicating compliance with the ethical approval given.
- A brief statement on the status of the project at the end of the period of approval or on completion of the project, whichever comes sooner.
- A request for renewal of approval if the project has not been completed by the end of the period of approval.

Please note that the Committee grants ethical approval only. If management approval from an institution/organisation is required, it is your responsibility to obtain this.

The Committee wishes you well with your research.

Please include the application number and study title in all correspondence and telephone queries.

Yours sincerely

A handwritten signature in black ink, appearing to read 'M. Banda', is written over a light grey background.

Madeline Banda
Executive Secretary
AUTEK

CC: 9814749 Maea Tita Emere Hohepa

From the desk of ...
Madeline Banda
Academic Services
Student Services Group

Private Bag 92006, Auckland 1020
New Zealand
E-mail: madeline.banda@aut.ac.nz

Tel: 64 9 917 9999
ext 8044
Fax: 64 9 917 9812

Appendix J: Consent Form for School Principals (Project 2)

Consent to Participation in Research (School Consent Form)



Title of Project: **Ngā Tirohanga o Te Whakapakari Tinana.
Perceptions of Physical Activity.**

Project Supervisors: **Dr Grant Schofield, Dr Gregory Kolt**

Researcher: **Maea Hohepa**

- I have read and understood the information provided about this research project
- I have had an opportunity to ask questions and to have them answered.
- I understand that I may withdraw permission to access the schools students at any time prior to completion of data collection, without being disadvantaged in any way.
- I agree Papakura High School can take part in this research.
- I wish to receive a copy of the report from the research.

Principal's signature:

Principal's name:

Principal's Contact Details:

.....
.....
.....

Date:

Approved by the Auckland University of Technology Ethics Committee on 29th April 2004 AUTEC
Reference number 04/68

Appendix K: Parental Consent Form (Project 2)

Consent to Participation in Research Parental Consent Form



This form is for parents to sign which indicates their consent for their child to participate in the study.

Title of Project: **Ngā Tirohanga o Te Whakapakari Tinana.**

Perceptions of Physical Activity.

Project Supervisors: **Dr Grant Schofield, Dr Gregory Kolt**

Researcher: **Maea Hohepa**

- I have read and understood the information provided about this research project
- I have had an opportunity to ask questions and to have them answered.
- I understand that the interview will be audio-taped and transcribed.
- I understand that I may withdraw my child or any information that my child has provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
- If I withdraw my child, I understand that all relevant tapes and transcripts, or parts thereof, will be destroyed.
- I agree my child can take part in this research.
- I wish to receive a copy of the report from the research.

Parent/Guardian signature:

Parent/ Guardian name:

Child's name:

Name of School Child Attends :

Parent / Guardian Contact:

Phone No.

Mob. No.....

Email Address:.....

Date:

Approved by the Auckland University of Technology Ethics Committee on 29th April 2004 AUTEK
Reference number 04/68

Appendix L: Participant Assent Form (Project 2)

Consent to Participation in Research (Participant Assent Form)



This form is for the adolescent to sign indicating he/she is willing to participate in the study.

Title of Project: **Ngā Tirohanga o Te Whakapakari Tinana.
Perceptions of Physical Activity.**

Project Supervisors: **Dr Grant Schofield, Dr Gregory Kolt**

Researcher: **Maea Hohepa**

-
- I have read and understood the information provided about this research project
 - I have had an opportunity to ask questions and to have them answered.
 - I understand that the interview will be audio-taped and transcribed.
 - I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
 - If I withdraw, I understand that all relevant tapes and transcripts, or parts thereof, will be destroyed.
 - I undertake to keep all discussion confidential to group members.
 - I agree to take part in this research.
 - I wish to receive a copy of the report from the research.

Participant signature:

Participant name:

Name of School Participant Attends :

Participant Contact Details

Phone No.

Mob. No.....

Email Address:.....

Date:

Approved by the Auckland University of Technology Ethics Committee on 29th April 2004 AUTEC
Reference number 04/68

Appendix M: Information Sheet for School Principals (Project 2)



School Information Sheet

Ngā Tirohanga o Te Whakapakari Tinana.
Perceptions of Physical Activity

My name is Maea Hohepa. Under the supervision of Dr Grant Schofield, I am undertaking this project to examine the perceptions of physical activity as part of my PhD studies at Auckland University of Technology. I would like to invite your school to participate in this project. Below is some information regarding the purpose of the project, and what the project involves.

Why conduct the research?

Being physically active is an important health behaviour for adolescents. The prevalence of overweight and obesity is on the increase in New Zealand for both adults and adolescents. Also, trends indicate physical activity levels decrease as children age especially during high school years. Gaining an understanding of the perceptions surrounding the health issue of physical inactivity will help provide a foundation of knowledge for developing effective health promotion initiatives.

What is the project about?

The aim of this project is to understand the thoughts Year 9 and Year 10 students have about physical activity.

What does the project involve?

- Participants will be involved in a focus group discussion about physical activity.
- Each focus group will discuss the benefits of, and the barriers to physical activity, and ways of helping youth become physically active.
- The focus groups will consist of 6 - 8 people.
- Participants will be included in a focus group that consists of students of similar age, and who are of the same ethnicity (Māori or New Zealand European) and gender.

When and where will the focus groups take place?

- If possible, the focus groups will be held on school premises at a time convenient to the school and the students.
- The focus group will take approximately one hour to complete.

What will happen at the focus group?

- The focus group will involve informal discussion about physical activity. A facilitator will ask some questions to the group and the participants' can say their opinions.
- Each focus group discussion will be audio taped to ensure all discussion points are collected.
- Refreshments will be supplied during each focus group.

What will happen with the information?

- From the audiotape discussions, common themes that emerge about the group's perceptions of physical activity will be identified.
- The information will be included in Maea's PhD research.
- A report of the findings will be provided to each school.

Anonymity and Confidentiality

- Due to the nature of focus groups, the focus group facilitator will be aware of the participants partaking in the study.
- Participants confidentiality is guaranteed because each participant will
 - 1. sign a consent form, which means each participant agrees to keep all discussions confidential to group members.
 - 2. be allocated a number for recording data. Data collection will occur without participants stating their name before each comment. Hence, identification of participants with their specific comments will not be possible.
- At no time will information be published that would identify a participant.
- Maea Hohepa will be involved with the transcription of the audio taped discussions, with the assistance of a bilingual expert if ethnic specific comments arise.
- The researchers involved in the study will be the only people with access to the research data.
- All data and consent forms will be stored in a locked room with limited

access on the premises of Auckland University of Technology. After ten years hard copies of the data/consent forms will be shredded. Computerised copies of the data will be erased.

Why be involved

- Being part of the focus group discussion has the potential to provide participants with strategies to become more physically active.
- Also, participants will be part of a study that aims to gain information to help develop interventions to assist young people and families lead a healthier lifestyle.
- After the research is completed schools and families of the participants will receive a fact sheet stating the main findings of the study.

Consent to Participate

- Giving consent on behalf of the school indicates you agree to give Maewa Hohepa permission to address the students of your school about the study and send information sheets and consent forms home with students who are potential participants.
- Also, based on discussion between school personnel and myself, the best system for returning consent forms will be considered.
- Signing and dating the school consent form indicates that you have freely given consent to participate, and that there has been no coercion or inducement to participate.

- Students who agree to participate understand participation in this study is completely voluntary and participants are free to withdraw consent and withdraw any information traceable to them and discontinue participation at any time without giving a reason before data collection is completed.

Do you have any questions?

If you have any questions about the study, please do not hesitate to contact one of the researchers.

Researcher Contact Details:

Maewa Hohepa
 Division of Sport and Recreation
 Faculty of Health
 Auckland University of Technology
 Private Bag 92006
 Auckland
 Tel: (09) 917-9999 ext 7848
 E-mail maewa.hohepa@auckland.ac.nz

Project Supervisors Contact Details:

Dr Grant Schofield
 Division of Sport and Recreation
 Faculty of Health
 Auckland University of Technology
 Private Bag 92006
 Auckland.
 Tel. (09) 917-9999 extn. 7307
 E-mail: grant.schofield@auct.ac.nz

Faculty of Health
 Auckland University of Technology
 Private Bag 92006
 Auckland.
 Tel. (09) 917-9999 extn. 7774
 E-mail: gregory.kolt@auct.ac.nz

Do you have any concerns?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor. Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, madeline.banda@auct.ac.nz, 917 9999 ext 8044.

Approved by the Auckland University of Technology Ethics Committee on 29th April 2004 AUTEC Reference 04/68

Prof Gregory Kolt

Appendix N: Information Sheet for Parents (Project 2)



Parent Information Sheet

Ngā Tirohanga o Te Whakapakari Tinana
Perceptions of Physical Activity

My name is Maea Hohepa. Under the supervision of Dr Grant Schofield, I am undertaking this project to examine the perceptions of physical activity as part of my PhD studies at Auckland University of Technology. I would like to invite your child (in Year 9 or Year 10) to participate in this project. Below is some information about the aim of the project, and what the project involves.

What is the project about?

- The aim of this project is to understand the thoughts Year 9 and Year 10 students have about physical activity.

What does the project involve?

- If you agree for your child to participate your child will be involved in a focus group discussion about physical activity.
- Each focus group will discuss the benefits of, and the barriers to physical

- activity, and ways of helping youth become physically active.
- Your child will be included in a focus group that consists of 6 – 8 students of similar age, and who are of the same ethnicity (Māori or New Zealand European) and gender as your child.

When and where will the focus groups take place?

- The focus group session will be held during school hours on school premises at a time that is convenient for both the school and the students. The focus group will take approximately one hour to complete.

What will happen at the focus groups?

- The focus group will involve informal discussion about physical activity. A facilitator will ask some questions to the group and the participants' can say their opinions.
- Each focus group discussion will be audio taped to ensure all discussion points are collected.
- Refreshments will be supplied during each focus group.

What will happen with the information?

- From the audio taped discussions, common themes that emerge about the group's perceptions of physical activity will be identified.
- The information will be included in Maea's PhD research.

Anonymity and Confidentiality

- Due to the nature of focus groups, the focus group facilitator will be aware of the participants partaking in the study.
 - Your child's confidentiality is guaranteed because each participant will sign a consent form, which means each participant agrees to keep all discussions confidential to group members.
 - be allocated a number for recording data. Data collection will occur without participants stating their name before each comment. Hence, identification of participants with their specific comments will not be possible.
 - At no time will information be published that would identify a participant.
 - Maea Hohepa will be involved with the transcription of the audio taped discussions, with the assistance of a bilingual expert if ethnic specific comments arise.
 - The researchers involved in the study will be the only people with access to the research data.
 - All data and consent forms will be stored in a locked room with limited access on the premises of Auckland University of Technology. After ten years hard copies of the data/consent forms will be shredded. Computerised copies of the data will be erased.
- Why be involved**
- Being part of the focus group discussion has the potential to provide

your child with strategies to become more physically active. Also, your child will be part of a study that aims to gain information to help develop interventions to assist young people and families lead a healthier lifestyle.

- After the project is completed each participant, and the participants family and school will receive a fact sheet stating the main findings of the study.

Consent to Participate

Participation in this study is completely voluntary and you and your child are free to withdraw consent and withdraw any information traceable to you or your child and discontinue participation at any time without giving a reason before data collection is completed.

What does your child have to do to participate?

- To participate in the study
 1. Your child needs to sign a participant assent form, which indicates your child agrees to participate.
 2. A parent/caregiver needs to sign the parental consent form (yellow form).

Where to return the consent form.

- Mahea Hohepa will collect the participant assent form after the information meeting with the students.
- Return the parental consent form to the school office at Papakura High School in the attached envelope.

Do you have a question about the project?

If you have any questions about the study, please do not hesitate to contact one of the researchers.

Researcher Contact Details:

Mahea Hohepa
Division of Sport and Recreation
Faculty of Health
Auckland University of Technology
Private Bag 92006
Auckland.
Tel: (09) 917-9999 ext 7848
E-mail: mahea.hohepa@auckland.ac.nz

Project Supervisors Contact Details:

Dr Grant Schofield
Division of Sport and Recreation
Faculty of Health
Auckland University of Technology
Private Bag 92006
Auckland.
Tel: (09) 917-9999 extn. 7307
E-mail: grant.schofield@aut.ac.nz

Prof Gregory Kolt
Faculty of Health
Auckland University of Technology
Private Bag 92006
Auckland.
Tel: (09) 917-9999 extn. 7774
E-mail: gregory.kolt@aut.ac.nz

Do you have any concerns about project conduct?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor. Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, madeline.banda@aut.ac.nz, 917 9999 ext 8044.

Approved by the Auckland University of Technology Ethics Committee on 29th April 2004 AUTEK Reference number 04/68

Appendix O: Information Sheet for Participants (Project 2)



Participant Information Sheet

Ngā Tirohanga o Te Whakapakari Tinana
Perceptions of Physical Activity

My name is Maea Hohepa. Under the supervision of Dr Grant Schofield, I am undertaking this project to examine the perceptions of physical activity as part of my PhD studies at Auckland University of Technology. I would like to invite you to participate in this project. Below is some information about the aim of the project and what the project involves.

What is the project about?

- The aim of this project is to understand the thoughts Year 9 and Year 10 students have about physical activity.

What do the participants have to do?

- If you agree to participate, you will be involved in a focus group discussion about physical activity.
- Each focus group will discuss the benefits of, and the barriers to physical activity, and ways of helping youth become physically active.
- The focus groups will consist of 6 - 8 people.

- You will be included in a focus group that consists of students of similar age, and who are of the same ethnicity (Māori, or New Zealand European) and gender as yourself.

When and where will the focus groups take place?

- The focus group session will be held during school hours on school premises. The focus group will take approximately one hour to complete.

What will happen at the focus groups?

- The focus group will involve informal discussion about physical activity. A facilitator will ask some questions to the group and the participants can say their opinions.
- Each focus group discussion will be audio taped to ensure all discussion points are collected.
- Refreshments will be supplied during each focus group.

What will happen with the information?

- From the audiotape discussions, common themes that emerge about the group's perceptions of physical activity will be identified.
- The information will be included in Maea's PhD research.

Anonymity and Confidentiality

- Due to the nature of focus groups, the focus group facilitator will be aware of the participants partaking in the study.

- Your confidentiality is guaranteed because each participant will sign a consent form, which means each participant agrees to keep all discussions confidential to group members.

- be allocated a number for recording data. Data collection will occur without participants stating their name before each comment. Hence, identification of participants with their specific comments will not be possible.

- At no time will information be published that would identify a participant.
- Maea Hohepa will be involved with the transcription of the audiotaped discussions, with the assistance of a bilingual expert if ethnic specific comments arise.
- The researchers involved in the study will be the only people with access to the research data.
- All data and consent forms will be stored in a locked room with limited access on the premises of Auckland University of Technology. After ten years hard copies of the data/consent forms will be shredded. Computerised copies of the data will be erased.

Why be involved

- Being part of the focus group discussion has the potential to provide you with strategies to become more physically active.
- Also, you will be part of a study that aims to gain information to help develop

interventions to assist young people and families lead a healthier lifestyle.

- After the research is completed your school, your family, and yourself will receive a fact sheet stating the main findings of the study.

What do you have to do to participate?

- To participate in the study you are required to
 1. Sign a participant assent form.
 2. Have your parent/caregiver sign the parental consent form (the yellow form).

- A parental consent form is required for participants under the age of 16 years.

Where to return the consent form

- Mahea Hohepa will collect the participant assent form after the information meeting with the students.
- Return the parental consent form to the school office at Papakura High School in the attached envelope.

Consent to participate

- Participation in this study is completely voluntary and you are free to withdraw consent and withdraw any information traceable to you and discontinue participation at any time without giving a reason before data collection is completed.

Do You Have Any Question About the Research?

If you have any questions about the study, please do not hesitate to contact one of the researchers.

Researcher Contact Details:

Mahea Hohepa
 Division of Sport and Recreation
 Faculty of Health
 Auckland University of Technology
 Private Bag 92006
 Auckland.
 Tel: (09) 917-9999 ext 7250
 E-mail: mahea.hohepa@auckland.ac.nz

Do You Have Any Concerns?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor. Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, madeline.banda@aut.ac.nz, 917 9999 ext 8044.

Approved by the Auckland University of Technology Ethics Committee on 29th April 2004 AUTEK Reference number 04/68

Project Supervisors Contact Details:

Dr Grant Schofield
 Division of Sport and Recreation
 Faculty of Health
 Auckland University of Technology
 Private Bag 92006
 Auckland.
 Tel: (09) 917-9999 extn. 7307
 E-mail: grant.schofield@aut.ac.nz

Prof Gregory Kolt
 Faculty of Health
 Auckland University of Technology
 Private Bag 92006
 Auckland.
 Tel: (09) 917-9999 extn. 7774
 E-mail: gregory.kolt@aut.ac.nz

Appendix P: Focus Group Schedule (Project 2)

Physical Activity Focus Group Question Schedule

Materials needed: audio recorder x2; refreshments.

Introductions:

Hi there. My name is ... and I'm here to talk to you today about what physical activities young (*Māori/ Pacific Island/ NZ European*) teenagers like to do and the kinds of things that influence what physical activities (*Māori/ Pacific Island/ NZ European*) teenagers participate in and why. This is (note takers name) and he/she will be writing down things you say so we don't forget what you have spoken.

- Ask each person to state their name and something about themselves that is unique.
- State the house rules regarding the discussion
 - Don't have to agree with others but respect their opinions
 - One persons speaks at any one time
 - What said in this room stays in this room
 - Let everyone have the chance to speak
- Does anyone have any questions before we start? Lets start our discussion about physical activity.

Question 1 Physical Activity: Tell me the type of physical activities you and other young (*Māori/ Pacific Island/ NZ European*) people do?

- *Getting to school*
- *During school time (lunch break, PE etc)*
- *After school*
- *Weekends*

Question 2 Benefits: What are some of the benefits of participating in physical activity for you and other young (*Māori / New Zealand European / Pacific Island*) people?

- *Social benefits*
- *Physical benefits*
- *Sport performance benefits*
- *Emotional / mental benefits*

Question 3 Barriers: Why are some young (*Māori / New Zealand European / Pacific Island*) not physically active?

- *Getting to school*
- *During school time (lunch break, PE etc)*
- *After school*
- *Weekends*

Question 4 Strategies: What could be done to help young (*Māori / New Zealand European / Pacific Island*) people be more physically active during (*school, weekend, after school, getting to school*)?

- *Help themselves*
- *Family*
- *School*
- *Change neighbourhood environment*

Wrap up: Are there things that you think are really important for us to know that I haven't asked about? Thanks & refreshments.

Appendix Q: Ethics Approval (Project 3)



THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

Research Office
Office of the Vice-Chancellor
The University of Auckland
Private Bag 92019
Auckland 1, New Zealand

Level 2, 76 Symonds Street
Auckland, New Zealand
Telephone: 64 9 - 373 7599 ext 87956
Facsimile: 64 9 - 373 7432

UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE

2 December, 2004

MEMORANDUM TO:

Assoc Prof Robert Scragg
School of Population Health

Re: Change to application

I wish to advise you that the Committee met on 1 December, 2004 and reviewed the request for change to your application titled "Baseline and Follow-up Cross-sectional Surveys in the Obesity Prevention in Communities (OPIC) Study of High School Students" (Our Ref. 2004 / 429).

The Committee approved the change.

If the project changes significantly you are required to resubmit your application to the Committee for further consideration.

In order that an up-to-date record can be maintained, it would be appreciated if you could notify the Committee once your project is completed.

Please contact the Chairperson if you have any specific queries relating to your application. She and the members of the Committee would be most happy to discuss general matters relating to ethics provisions if you wish to do so.

Margaret Rotondo
Executive Secretary
University of Auckland Human Subjects Ethics Committee

c.c. Head of Department, School of Population Health

1. All communications with the committee regarding this application should indicate this reference number - (2004/429).
2. At the end of the three years, or earlier if the project is completed, you are requested to advise the Committee of its completion.

Appendix R: Consent Form for School Principals (Project 3)



The University of Auckland
Private Bag 920 19
Auckland, New Zealand,

School of Population Health,
Morrin Rd, Tamaki, Auckland.
www.health.auckland.ac.nz

Telephone: 64 9 373 7599 extn 86336
Facsimile: 64 9 3737 624
Email: r.scragg@auckland.ac.nz

Consent Form for School Principals

Obesity prevention study of high school students

Researchers: Associate-Professor Robert Scragg
Professor David Thomas
Mr David Schaaf
School of Population Health, Tamaki Campus, University of Auckland

- I have been given, and have understood, an explanation of this research project. I have had an opportunity to ask questions and have them answered.
- I understand that students may withdraw themselves, or any information traceable to them, without giving a reason at any time up to 30 April 2008.
- I agree for students at my school to be invited to take part in this research

Signed by **teacher:** _____

Name: _____
(please print clearly)

Date:

Name of School: _____

“APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE on to for a period ofyears, Reference Number/.....”

Appendix S: Participant Assent and Parental Consent Form (Project 3)



The University of Auckland
Private Bag 92019
Auckland, New Zealand.

School of Population Health,
Morrin Rd, Tamaki, Auckland.
www.health.auckland.ac.nz

Telephone: 64 9 373 7599 extn 86336
Facsimile: 64 9 3737 624
Email: r.scragg@auckland.ac.nz

Consent Form for Students aged less than 16 years & Parents

Obesity prevention study of high school students

Researchers: Associate-Professor Robert Scragg
Professor David Thomas
Mr David Schaaf
School of Population Health, Tamaki Campus, University of Auckland

- I have been given, and have understood, an explanation of this research project. I have had an opportunity to ask questions and have them answered.
- I understand that I may withdraw myself, or any information traceable to me, without giving a reason at any time up to 30 April 2008.
- I agree to take part in this research

Signed by **student:** _____

Name: _____ Date:
(please print clearly)

I agree for my son/daughter to take part in this research

Signed by **parent:** _____
(or guardian)

Name: _____ Date:
(please print clearly)

**"APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS
COMMITTEE on 01/12/2004 to 31/11/2007 for a period of 3 years, Reference Number 2004/429"**

Appendix T: Participant Consent Form (Project 3)



The University of Auckland
Private Bag 92019
Auckland, New Zealand.

School of Population Health,
Morrin Rd, Tamaki, Auckland.
www.health.auckland.ac.nz

Telephone: 64 9 373 7599 extn 86336
Facsimile: 64 9 3737 624
Email: r.scragg@auckland.ac.nz

Consent Form for Students aged 16 years or above

Obesity prevention study of high school students

Researchers: Associate-Professor Robert Scragg
Professor David Thomas
Mr David Schaaf
School of Population Health, Tamaki Campus, University of Auckland

- I have been given, and have understood, an explanation of this research project. I have had an opportunity to ask questions and have them answered.
- I understand that I may withdraw myself, or any information traceable to me, without giving a reason at any time up to 30 April 2008.
- I agree to take part in this research

Signed by **student:** _____

Name: _____
(please print clearly)

Date:

“APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE on to for a period ofyears, Reference Number/.....”

Appendix U: Information Sheet for Students Aged < 16 years old (Project 3)



The University of Auckland
Private Bag 92019
Auckland, New Zealand,

School of Population Health,
Morris Rd, Tamaki, Auckland,
www.health.auckland.ac.nz

Telephone: 64 9 373 7599 extn 86336
Facsimile: 64 9 3737 624
Email: r.scragg@auckland.ac.nz

Information Sheet for Students aged less than 16 years

Obesity prevention study of high school students

You are invited to take part in this research project which is being carried out by researchers from the School of Population Health, Tamaki Campus, University of Auckland. Students attending several South Auckland high schools are being invited to take part in this study. The research project is funded by the Health Research Council of New Zealand.

Why are we doing this study?

Obesity levels are increasing rapidly among young people in New Zealand. The purpose of this research project is to see if obesity levels in high school students can be reduced by programs to prevent obesity in schools and the wider community. During 2005 to 2007, the obesity prevention program will be carried out in half of the schools surveyed, and not in the other half of the schools which will be a control. However, the intervention program will take place in control schools during 2008, so students at all survey schools will receive the obesity prevention program by 2008. If the survey is successful, obesity prevention programs may, in the future, be offered more widely to other schools not involved in the survey.

Who is being surveyed?

This study involves about 5000 students enrolled at several schools in South Auckland. Students in Year 9 and above will be approached by study researchers to take part, and if aged less than 16 years will require the written consent of their parent or guardian.

Do I have to take part in this survey?

Participation is entirely voluntary and you may decline without giving any reasons. If you choose to participate you may withdraw from the survey, or withdraw any information that may identify you, at any time up to 30 June 2008. If you do not want to participate in the research, the Principal has given an assurance it will not affect your assessment, grades or standing at school.

What is involved?

Should you agree to participate in this study, along with other students in your class who have agreed to participate, you will have a baseline interview lasting about an hour. This involves: answering a questionnaire on family contact details, diet, physical activity and neighbourhood environment; and measurement of weight, height, waist circumference and body fat. The interview will be repeated a second time during the 3 year follow-up period of the survey. Year 11 and 12 students in 2005 will be offered a 3rd interview (the same as the baseline interview), should they continue into Year 13.

The interviews will take place at school, and will be supervised by our research team. If you do not want to participate, you will continue your school activities in a separate room while participating students are being interviewed.

What about my privacy?

No information that could personally identify you will be used in any reports from this study. Your answers to the questions will be stored securely. Data will be stored indefinitely on computer, but will not contain your name, address, family details or any other information that could identify you.

The results of the survey will be given to participating school boards, local District Health Boards and relevant government ministries.

What are the benefits and risks of the study?

Students at the intervention schools may benefit from decreased weight gain if the obesity prevention is successful. This may lead to ways of preventing obesity in young people. Students at control schools will be offered the intervention in 2008.

The only risk involved with taking part is the possibility of embarrassment from talking about obesity. Our research interviewers are trained to respond to this. In the unlikely event of any injury from participating in this survey, you will be covered by the Accident Rehabilitation and Compensation Act 1993.

Contact persons

If you have any questions about the survey, please contact the following study researchers in the School of Population Health, University of Auckland;

Associate-Professor Robert Scragg (3737 599 ext 86336) or
Professor David Thomas (3737 599, ext 85657) or
Mr David Schaaf (3737 599, ext 86347)

The Head of Section is: Professor Rod Jackson
Epidemiology & Biostatistics Section, School of Population Health, Tamaki Campus
University of Auckland, Morrin Road, Tamaki Tel: 3737 599 ext 86343

If you have any queries or ethical concerns regarding your rights as a participant of this study, you may wish to contact:

The Chair, **University of Auckland Human Participants Ethics Committee**
Office of the Vice Chancellor, Research Office,
Level 2, 76 Symonds St, Auckland Tel: 373 7599 ext 87830

"APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE on to for a period ofyears, Reference Number/....."

Appendix V: Information Sheet for Students Aged ≥ 16 years old (Project 3)



The University of Auckland
Private Bag 92019
Auckland, New Zealand.

School of Population Health,
Morris Rd. Tamaki, Auckland.
www.health.auckland.ac.nz

Telephone: 64 9 373 7599 extn 86336
Facsimile: 64 9 3737 503
Email: r.scragg@auckland.ac.nz

Information Sheet for Students aged 16 years and older

Obesity prevention study of high school students

You are invited to take part in this research project which is being carried out by researchers from the School of Population Health, Tamaki Campus, University of Auckland. Students attending several South Auckland high schools are being invited to take part in this study. The research project is funded by the Health Research Council of New Zealand.

Why are we doing this study?

Obesity levels are increasing rapidly among young people in New Zealand. The purpose of this research project is to see if obesity levels in high school students can be reduced by programs to prevent obesity in schools and the wider community. During 2005 to 2007, the obesity prevention program will be carried out in half of the schools surveyed, and not in the other half of the schools which will be a control. However, the intervention program will take place in control schools during 2008, so students at all survey schools will receive the obesity prevention program by 2008. If the survey is successful, obesity prevention programs may, in the future, be offered more widely to other schools not involved in the survey.

Who is being surveyed?

This study involves about 5000 students enrolled at several schools in South Auckland. Students in Year 9 and above will be approached by study researchers to take part, and if aged less than 16 years will require the written consent of their parent or guardian.

Do I have to take part in this survey?

Participation is entirely voluntary and you may decline without giving any reasons. If you choose to participate you may withdraw from the survey, or withdraw any information that may identify you, at any time up to 30 June 2008. If you do not want to participate in the research, the Principal has given an assurance it will not affect your assessment, grades or standing at school.

What is involved?

Should you agree to participate in this study, along with other students in your class who have agreed to participate, you will have a baseline interview lasting about an hour. This involves: answering a questionnaire on family contact details, diet, physical activity and neighbourhood environment; and measurement of weight, height, waist circumference and body fat. The interview will be repeated a second time during the 3 year follow-up period of the survey. Year 11 and 12 students in 2005 will be offered a 3rd interview (the same as the baseline interview), should they continue into Year 13.

The interviews will take place at school, and will be supervised by our research team. If you do not want to participate, you will continue your school activities in a separate room while participating students are being interviewed.

What about my privacy?

No information that could personally identify you will be used in any reports from this study. Your answers to the questions will be stored securely. Data will be stored indefinitely on computer, but will not contain your name, address, family details or any other information that could identify you.

The results of the survey will be given to participating school boards, local District Health Boards and relevant government ministries.

What are the benefits and risks of the study?

Students at the intervention schools may benefit from decreased weight gain if the obesity prevention is successful. This may lead to ways of preventing obesity in young people. Students at control schools will be offered the intervention in 2008.

The only risk involved with taking part is the possibility of embarrassment from talking about obesity. Our research interviewers are trained to respond to this. In the unlikely event of any injury from participating in this survey, you will be covered by the Accident Rehabilitation and Compensation Act 1993.

Contact persons

If you have any questions about the survey, please contact the following study researchers in the School of Population Health, University of Auckland;

Associate-Professor Robert Scragg (3737 599 ext 86336) or
Professor David Thomas (3737 599, ext 85657) or
Mr David Schaaf (3737 599, ext 86347)

The Head of Section is: Professor Rod Jackson
Epidemiology & Biostatistics Section, School of Population Health, Tamaki Campus
University of Auckland, Morrin Road, Tamaki Tel: 3737 599 ext 86343

If you have any queries or ethical concerns regarding your rights as a participant of this study, you may wish to contact:

The Chair, **University of Auckland Human Participants Ethics Committee**
Office of the Vice Chancellor, Research Office,
Level 2, 76 Symonds St, Auckland Tel: 373 7599 ext 87830

"APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE on to for a period ofyears, Reference Number/....."

Appendix W: Information Sheet for Parents (Project 3)



The University of Auckland
Private Bag 92019
Auckland, New Zealand.

School of Population Health,
Morrin Rd, Tamaki, Auckland.
www.health.auckland.ac.nz

Telephone: 64 9 373 7599 extn 86336
Facsimile: 64 9 3737 624
Email: r.scragg@auckland.ac.nz

Information Sheet for Parents

Obesity prevention study of high school students

Your son/daughter is invited to take part in this research project which is being carried out by researchers from the School of Population Health, Tamaki Campus, University of Auckland. Students attending several South Auckland high schools are being invited to take part in this study. The research project is funded by the Health Research Council of New Zealand.

Why are we doing this study?

Obesity levels are increasing rapidly among young people in New Zealand. The purpose of this research project is to see if obesity levels in high school students can be reduced by programs to prevent obesity in schools and the wider community. During 2005 to 2007, the obesity prevention program will be carried out in half of the schools surveyed, and not in the other half of the schools which will be a control. However, the intervention program will take place in control schools during 2008, so students at all survey schools will receive the obesity prevention program by 2008. If the survey is successful, obesity prevention programs may, in the future, be offered more widely to other schools not involved in the survey.

Who is being surveyed?

This study involves about 5000 students enrolled at several schools in South Auckland. Students in Year 9 and above will be approached by study researchers to take part, and if aged less than 16 years will require the written consent of their parent or guardian.

Do your son/daughter have to take part in this survey?

Participation is entirely voluntary and your son/daughter may decline without giving any reasons. If he/she chooses to participate they may withdraw from the interview, or withdraw any information that may identify them, at any time up to 30 June 2008. If your son/daughter does not want to participate in the research, the Principal has given an assurance it will not affect his/her assessment, grades or standing at school.

What is involved?

Should your son/daughter agree to participate in this study, along with other students in your class who have agreed to participate, he/she will have a baseline interview lasting about an hour. This involves: answering a questionnaire on family contact details, diet, physical activity and neighbourhood environment; and measurement of weight, height, waist circumference and body fat. The interview will be repeated a second time during the 3 year follow-up period of the survey. Year 11 and 12 students in 2005 will be offered a 3rd interview (the same as the baseline interview), should they continue into Year 13.

The interviews will take place at school, and will be supervised by our research team. If your son/daughter does not want to participate, he/she will continue his/her school activities in a separate room while participating students are being interviewed.

What about privacy?

No information that could personally identify you or son/daughter will be used in any reports from this study. The answers from your son/daughter to the questions will be stored securely. Data will be stored indefinitely on computer, but will not contain the name of your son/daughter, address, family details or any other information that could identify you or your son/daughter.

The results of the survey will be given to participating school boards, local District Health Boards and relevant government ministries.

What are the benefits and risks of the study?

Students at the intervention schools may benefit from decreased weight gain if the obesity prevention is successful. This may lead to ways of preventing obesity in young people. Students at control schools will be offered the intervention in 2008.

The only risk involved with taking part is the possibility of embarrassment from talking about obesity. Our research interviewers are trained to respond to this. In the unlikely event of any injury from participating in this survey, you son/daughter will be covered by the Accident Rehabilitation and Compensation Act 1993.

Contact persons

If you have any questions about the survey, please contact the following study researchers in the School of Population Health, University of Auckland;

Associate-Professor Robert Scragg (3737 599 ext 86336) or
Professor David Thomas (3737 599, ext 85657) or
Mr David Schaaf (3737 599, ext 86347)

The Head of Section is: Professor Rod Jackson
Epidemiology & Biostatistics Section, School of Population Health, Tamaki Campus
University of Auckland, Morrin Road, Tamaki Tel: 3737 599 ext 86343

If you have any queries or ethical concerns regarding the rights of your son/daughter as a participant in this study, you may wish to contact:

The Chair, **University of Auckland Human Participants Ethics Committee**
Office of the Vice Chancellor, Research Office,
Level 2, 76 Symonds St, Auckland Tel: 373 7599 ext 87830

"APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE on 01/12/2004 to 31/11/2007 for a period of 3 years, Reference Number 2004/429"

Appendix X: Survey Questions (Project 3)

OPIC BASELINE DATA DICTIONARY (E-STEPS)
15 February 2006

Variable label	Question	Response options
TDAY1	Is this today's date? day	1-31
TMONTH1	Is this today's date? month	1-12
TYEAR1	Is this today's date? year	2004-2008
COUNTRY	Which country is this?	1,Australia 2,Fiji Islands 3,New Zealand
SCHNAM1	What is the name of the school?	1, XXXX 2, XXXX 3, XXXX 4, XXXX 5, XXXX 6, XXXX 7, XXXX
YEAR1NA	What year are you in?	1,9 2,10 3,11 4,12 5,13
ETHNICN1	Which ethnic group do you most identify with? (Choose one)	1, Maori 2, Samoan 3, Cook Island Maori 4, Tongan 5, Niuean 6, Other Pacific 7, NZ European / Pakeha 8, Other European eg. English/Dutch 9, Chinese 10, Indian 11, Other
BORNNZ1	Were you born in New Zealand?	1, Yes 2, No
LONGNZ1	How long have you lived in New Zealand? Please choose a response closest to the nearest whole year	1,0 2,1 3,2 4,3 5,4 6,5 7,6 8,7 9,8 10,9 11,10 12,11 13,12 14,13 15,14 16,15 17,16 18,17 19,18
SEX1		1, Male 2, Female
DOB1D	What is your date of birth? day	1-31

School names removed for confidentiality reasons

DOB1M	What is your date of birth? month	1,Jan 2,Feb 3, March 4, April 5, May 6, June 7, July 8, Aug 9, Sept 10, Oct 11, Nov 12, Dec
DOB1Y	What is your date of birth? year	1,1985 2,1986 3,1987 4,1988 5,1989 6,1990 7,1991 8,1992 9,1993
CHURCH1	Do you belong to a Church, Temple or Mosque?	1, No 2, Yes belong to a Church 3, Yes belong to a Temple 4, Yes belong to a Mosque
OFTENCH1	How often have you gone to Church activities in the past 12 months? (including services, Sunday school, youth groups and choir practice)	1, Usually weekly or more often 2, 2-3 times a month 3, Once a month 4, Less than once a month
TEMPLE1	How often have you gone to Temple activities in the past 12 months? (including services, youth groups and choir practice)	1, Usually weekly or more often 2, 2-3 times a month 3, Once a month 4, Less than once a month
MOSQ1	How often have you gone to Mosque activities in the past 12 months? (including services, youth groups and choir practice)	1, Usually weekly or more often 2, 2-3 times a month 3, Once a month 4, Less than once a month
LIVEPAR1	Do you live with your parents/step-parents during the school week?	1, Yes with two parents 2, Yes with one parent 3, Don't live with my parents
LIVEWIT1	Do you live with other ADULT relatives during the school week? (e.g. grandparents, uncle, aunt, cousin)	1, Yes 2, No
HOWMANY1	How many people usually live at your home, including yourself during the school week?	1,1 2,2 3,3 4,4 5,5 6,6 7,7 8,8 9,9 10,10 11,11
BREAKFR1	On school days, where do you usually get your breakfast from?	1, Home 2, School canteen or tuckshop 3, Shop (outside school) 4, From friends 5, I don't eat breakfast

BREAKBS1	In the last 5 school days, on how many days did you have something to eat for BREAKFAST before school started?	1,0 days 2,1 day 3,2 days 4,3 days 5,4 days 6,5 days
MTFROM1	Where do you usually get your morning tea from?	1,Home 2,School canteen or tuckshop 3,Shop (outside school) 4,From friends 5,I don't eat morning tea
RECESS1	In the last 5 school days, on how many days did you eat at morning recess/tea/ interval?	1,0 days 2,1 day 3,2 days 4,3 days 5,4 days 6,5 days
LUNFROM1	Where do you usually get your lunch from?	1,Home 2,School canteen or tuckshop 3,Shop (outside school) 4,From friends 5,I don't eat lunch
LUNCH1	In the last 5 school days, on how many days did you eat lunch at lunchtime?	1,0 days 2,1 day 3,2 days 4,3 days 5,4 days 6,5 days
FRUIFR1	How many serves of fruit do you usually eat each day? (a serve = 1 apple or 2 plums or 1 cup of diced fruit)	1,1 serve or less 2,2 to 3 serves 3,4 serves or more
FRUITS1A	How many serves of vegetables do you usually eat each day? (1 serve = 1/2 cup cooked vegetables or 1 cup of raw vegetables/salad)	1,1 serve or less 2,2 to 3 serves 3,4 serves or more
SOFTDRI1	In the last 5 school days (including time spent at home), on how many days did you have regular (non-diet) soft drinks? (Soft drinks = drinks like Coke, Sprite, Fanta)	1,0 days 2,1 day 3,2 days 4,3 days 5,4 days 6,5 days
FRSODFR1	On the last school day, how many glasses or cans of soft drinks did you have?	1,None 2,1 small glass / half a can (150ml) 3,2 small glasses / 1 can (300ml) 4,3 small glasses / 2 cans (600ml) 5,4-5 glasses / 3 cans (1 litre) 6,6 glasses / 4 cans (1.5 litres) 7,7-8 glasses / 6 cans (2 litres) 8,More than 2 litres
FRUDRIN1	In the last 5 school days, on how many days did you have fruit drinks or cordial? (such as Ribena, Raro, Just Juice, Freshup)	1,0 days 2,1 day 3,2 days 4,3 days 5,4 days 6,5 days

FREFRDR1	On the last school day, how many glasses of fruit drinks or cordial did you have?	1,0 2,1 3,2 4,3 5,4 6,5 7,6 8,7 9,8 10,9
MACCAS1	How often do you usually eat food from a takeaway? (eg. McDonalds, KFC, Subway, fried chicken, fish and chips, hamburgers, Chinese takeaway)	1,Once a month or less 2,2-3 times a month 3,Once a week 4,2-3 times a week 5,Most days
SNACKFOA	In the last 5 school days, on how many days did you buy snack food from a shop or takeaway after school?	1,0 days 2,1 day 3,2 days 4,3 days 5,4 days 6,5 days
FRUITF1	How often do you usually eat fruit after school?	1,Everyday or almost everyday 2,Most days 3,Some days 4,Hardly ever or never
BREADF1	How often do you usually eat bread, toast, buns or sandwiches after school?	1,Everyday or almost everyday 2,Most days 3,Some days 4,Hardly ever or never
SNACKF1	How often do you usually eat biscuits, potato chips or snacks such as instant noodles after school?	1,Everyday or almost everyday 2,Most days 3,Some days 4,Hardly ever or never
FRIEDF1	How often do you usually eat pies, takeaways or fried foods such as french fries after school?	1,Everyday or almost everyday 2,Most days 3,Some days 4,Hardly ever or never
CHOC1	How often do you usually eat chocolates, lollies, sweets or ice cream after school?	1,Everyday or almost everyday 2,Most days 3,Some days 4,Hardly ever or never
WALK2SC1	In the last 5 school days, how many times did you walk or bike to or from school? (walking from home to school and back on 1 day is 2 times: walking to school and taking the bus home is 1 time)	1,0 2,1 3,2 4,3 5,4 6,5 7,6 8,7 9,8 10,9 11,10 12,more than 10
WALKTIM1	How long does it take you to walk from home to your school?	1,Less than 15 minutes 2,15 - 30 minutes 3,More than 30 minutes
WALKLO1	How long would it take to walk from home to your school?	1,Less than 15 minutes 2,15 - 30 minutes 3,More than 30 minutes

RECESA1	Over the last 5 school days, what did you do most of the time at morning recess/ interval (apart from eating)?	1,Mostly just sat down 2,Mostly stood or walked around 3,Mostly played active games
LUNCHA1	In the last 5 school days, what did you do most of the time at lunch time (apart from eating)?	1,Mostly just sat down 2,Mostly stood or walked around 3,Mostly played active games
ACTIVITA	In the last 5 school days, on how many days after school, did you do sports, dance, cultural performances or play games in which you were active?	1,0 days 2,1 day 3,2 days 4,3 days 5,4 days 6,5 days
TVDAYS1A	In the last 5 school days, how many days did you watch TV, videos or DVDs (in your free time)?	1,0 days 2,1 day 3,2 days 4,3 days 5,4 days 6,5 days
TVHRS1	On the last school day that you watched TV, videos or DVDs, how long did you watch for?	1,Less than 1 hour 2,1 hour 3,2 hours 4,3 hours 5,4 hours 6,More than 4 hours
TVSAT1	Last Saturday, how many hours did you spend watching TV, videos or DVDs?	1,0 2,1 3,2 4,3 5,4 6,5 7,6 8,7 9,8 10,9 11,10 12,more than 10
TVSUN1	Last SUNDAY, how many hours did you spend watching TV, videos or DVDs?	1,0 2,1 3,2 4,3 5,4 6,5 7,6 8,7 9,8 10,9 11,10 12,more than 10
TVLIMIT1	During the school week, do your parents (or caregivers) limit the amount of TV you are allowed to watch? (including videos and DVDs)	1,No limits - I can watch anything 2,Yes - but not very strict limits 3,Yes - strict limits
TVMEAL1A	In the last 5 school days, how many times did you watch TV while eating your evening meal?	1,0 days 2,1 day 3,2 days 4,3 days 5,4 days 6,5 days
TVHOME1	Do you have a TV in your home?	1,Yes 2,No

TVROOM1	Do you have a TV in your bedroom?	1,Yes 2,No
COMPFREA	In the last 5 school days, how many days did you play video games, electronic games or use the computer? (not for homework)	1,0 days 2,1 day 3,2 days 4,3 days 5,4 days 6,5 days
COMPHRS1	On the last school day that you spent time playing video games or using the computer (not for homework), how long did you play for?	1,Have not played for ages 2,Less than 1 hour 3,1 hour 4,2 hours 5,3 hours 6,4 hours 7,More than 4 hours
COMPSAT1	Last Saturday, how many hours did you spend playing video games or using the computer (not for homework)?	1,0 hours 2,Less than 1 hour 3,1 hour 4,2 hours 5,3 hours 6,4 hours 7,5 hours 8,More than 5 hours
COMPSUN1	Last SUNDAY, how many hours did you spend playing video games, or using the computer? (not for homework)	1,0 hours 2,Less than 1 hour 3,1 hour 4,2 hours 5,3 hours 6,4 hours 7,5 hours 8,More than 5 hours
COMPHO1	Do you have video games, electronic games or a computer in your home?	1,Yes 2,No
DESWEIG1	How would you describe your weight?	1,Very underweight 2,Slightly underweight 3,About the right weight 4,Slightly overweight 5,Very overweight
HAWEIGH1	How happy or unhappy are you with your BODY WEIGHT?	1,Very happy 2,Happy 3,In between / OK 4,Unhappy 5,Very unhappy 6,Never thought about my body weight
HASIZE1	How happy or unhappy are you with your BODY SHAPE?	1,Very happy 2,Happy 3,In between / OK 4,Unhappy 5,Very unhappy 6,Never thought about my shape
STATEMEN	Which of these statements most closely applies to you? I am...	1,trying to lose weight 2,trying to gain weight 3,trying to stay at my current weight 4,not doing anything about my weight
MUSCLE1	Which of the following statements most closely applies to you? I am...	1,trying to gain muscle size 2,trying to stay at the same muscle size 3,not doing anything about my muscles

MOTHSUP1	How much does your mother (or female caregiver) encourage you to eat healthy foods?	1,A lot 2,Some 3,A little 4,Not at all 5,Don't live with my mother
FATHSUP1	How much does your father (or male caregiver) encourage you to eat healthy foods?	1,A lot 2,Some 3,A little 4,Not at all 5,Don't live with my father
TAKEAWD1	How often do you have food from a takeaway shop for dinner?	1,More than once a week 2,About once a week 3,2-3 times a month 4,Once a month or less
FRUITAV1	How often is fruit available at home for you to eat?	1,Everyday or almost everyday 2,Most days 3,Some days 4,Hardly ever or never
CHIPSAV1	How often are potato chips or similar snacks available at home for you to eat?	1,Everyday or almost everyday 2,Most days 3,Some days 4,Hardly ever or never
CHOCAV1	How often are chocolates or sweets available at home for you to eat?	1,Everyday or almost everyday 2,Most days 3,Some days 4,Hardly ever or never
SOFTDAV1	How often are non-diet soft drinks available at home for you to drink? (Soft drinks = drinks like Coke, Sprite, Fanta)	1,Everyday or almost everyday 2,Most days 3,Some days 4,Hardly ever or never
MONSPN1A	On the last school day, how much money did you spend on food or drinks for yourself at takeaway shops or dairies? (not including school canteens)	1,0 2,1 3,2 4,3 5,4 6,5 7,6 8,7 9,8 10,9 11,10 12,11 13,12 14,13 15,14 16,15
SUPMAC1	How much does your mother (or female caregiver) encourage you to be physically active or play sports?	1,A lot 2,Some 3,A little 4,Not at all 5,Don't live with my mother
SUPFACT1	How much does your father (or male caregiver) encourage you to be physically active or play sports?	1,A lot 2,Some 3,A little 4,Not at all 5,Don't live with my father

SUPBACT1	How much do your older brothers or male cousins encourage you to be physically active or play sports?	1,A lot 2,Some 3,A little 4,Not at all 5,Don't have older brother/cousin
SUPSAC1	How much do your older sisters or female cousins encourage you to be physically active or play sports?	1,A lot 2,Some 3,A little 4,Not at all 5,Don't have older sister/cousin
SUPFRND1	How much do your best friends encourage you to be physically active or play sports?	1,A lot 2,Some 3,A little 4,Not at all
MEALTOGA	In the last 5 school days, how many times did all or most of your family living in your house eat an evening meal together?	1,0 days 2,1 day 3,2 days 4,3 days 5,4 days 6,5 days
SENCSP01	How much does your school encourage ALL students to play organised sport?	1,A lot 2,Some 3,A little 4,Not at all
SENCAC1	How much does your school encourage ALL students to be physically active at lunchtime?	1,A lot 2,Some 3,A little 4,Not at all
TEACHPA1	How do you rate the teachers at your school as role models for being physically active?	1,Excellent 2,Good 3,OK 4,Not very good 5,Poor
TEACHHE1	How do you rate the teachers at your school as role models for HEALTHY EATING?	1,Excellent 2,Good 3,OK 4,Not very good 5,Poor
CANTEEN1	How do you rate the food and drink choices available at your school canteen?	1,Mostly healthy 2,Half healthy / half unhealthy 4,Mostly unhealthy
SENCHE1	How much does your school encourage students to make healthy food choices?	1,A lot 2,Some 3,A little 4,Not at all
SAFEA1	How safe do you feel being out alone in your neighbourhood at night?	1,Very safe 2,Safe 3,Unsafe 4,Very unsafe
SAFEPAR1	How safe do your parents (or caregivers) think it is for you to be out alone in your neighbourhood at night?	1,Very safe 2,Safe 3,Unsafe 4,Very unsafe 5,Don't know
SAFDOG1	How much do dogs bother you when you are walking in your neighbourhood?	1,A lot 2,Somewhat 3,A little 4,Not at all

SAFETRA1	How much does traffic bother you when you are walking in your neighbourhood?	1,A lot 2,Somewhat 3,A little 4,Not at all
SAFSTR1	How much do other people bother you when you are walking in your neighbourhood?	1,A lot 2,Somewhat 3,A little 4,Not at all
CHHEAT1	How much does your Church support healthy eating?	1,A lot 2,Somewhat 3,A little 4,Not at all
TEHEAT1	How much does your Temple support healthy eating?	1,A lot 2,Somewhat 3,A little 4,Not at all
MOHEAT1	How much does your Mosque support healthy eating?	1,A lot 2,Somewhat 3,A little 4,Not at all
LEADHE1	How do you rate the leaders at your Church as role models for EATING HEALTHY FOODS?	1,Excellent 2,Good 3,OK 4,Not very good 5,Poor
LEADT1	How do you rate the leaders at your Temple as role models for EATING HEALTHY FOODS?	1,Excellent 2,Good 3,OK 4,Not very good 5,Poor
LEADM1	How do you rate the leaders at your Mosque as role models for EATING HEALTHY FOODS?	1,Excellent 2,Good 3,OK 4,Not very good 5,Poor
LEADPAC1	How do you rate the leaders at your Church as role models for PHYSICAL ACTIVITY?	1,Excellent 2,Good 3,OK 4,Not very good 5,Poor
LEADPAT1	How do you rate the leaders at your Temple as role models for PHYSICAL ACTIVITY?	1,Excellent 2,Good 3,OK 4,Not very good 5,Poor
LEADPAM1	How do you rate the leaders at your Mosque as role models for PHYSICAL ACTIVITY?	1,Excellent 2,Good 3,OK 4,Not very good 5,Poor
SKIPBR1	Skipping breakfast or lunch is a good way to lose weight	1,Strongly agree 2,Agree 3,Neither agree nor disagree 4,Disagree 5,Strongly disagree
DRINKSU1	Fruit drinks and cordials have less sugar than non-diet soft drinks like Coke and Sprite.	1,Strongly agree 2,Agree 3,Neither agree nor disagree 4,Disagree 5,Strongly disagree

TVWEIGH1	Watching a lot of TV does not lead to weight gain.	1, Strongly agree 2, Agree 3, Neither agree nor disagree 4, Disagree 5, Strongly disagree
FVWEIG1	Eating a lot of fruit and vegetables is bad for your weight	1, Strongly agree 2, Agree 3, Neither agree nor disagree 4, Disagree 5, Strongly disagree

Appendix Y: Adolescent Obesity and Physical Inactivity

THE NEW ZEALAND MEDICAL JOURNAL

Vol 117 No 1207 ISSN 1175 8716



Adolescent obesity and physical inactivity

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Abstract

Globally, obesity and physical inactivity are two health issues affecting young people. In New Zealand, the most current statistics indicate that 33.6% of 11 to 14 year olds, and 27% of 15 to 18 year olds, are considered overweight or obese.^{1,2} Despite these high prevalence levels, only 38% of young people aged 13 to 17 years in New Zealand are considered physically inactive.³

Future effort needs to be directed towards enhancing the existing national surveys to ensure a comprehensive and valid surveillance system of adolescent obesity and inactivity is conducted on a regular basis. This would involve the development of age, sex, and ethnic specific body mass index cut-off thresholds to define overweight and obesity, validation of an adolescent questionnaire that examines physical activity from a broad perspective, and development of physical activity recommendations for youth based on international best practice.

Although the main focus of this paper is on obesity and physical inactivity, diet is also a key determinant of obesity. Therefore, to provide an accurate assessment of factors associated with youth obesity in New Zealand, surveillance of diet must occur concurrently with that of obesity and physical activity.

The development of accurate measurement tools is critical for (1) determining obesity and inactivity trends, (2) identifying at-risk groups, (3) tracking progress toward national health priorities, and (4) evaluating the efficacy of interventions targeting obesity and physical inactivity. Furthermore, attention needs to be directed towards identifying correlates of inactivity and obesity to help inform the development of comprehensive multisectorial, multisetting, prevention, and management initiatives.

The worldwide prevalence of overweight and obesity among the adult population is reaching epidemic proportions, and evidence indicates children and adolescents are following in this trend. Obesity and physical inactivity are two interrelated health issues with a cyclic relationship. That is, physical inactivity plays a key role in the development and management of obesity, while obesity often impacts negatively on an individual's level of physical activity.

Obesity is a complex phenomenon that is influenced by genetic, behavioural, and environmental factors. A positive balance between energy expenditure and energy intake is a possible underlying cause of obesity. The increase in obese living environments (i.e. environments that encourage sedentary pursuits, energy saving activities, and excessive consumption of high density, high fat food) has likely supported this positive energy balance. Current evidence supports an association between sedentary activities such as television viewing and obesity during childhood and adolescence.⁴

The financial burden of obesity and physical inactivity is substantial. It is estimated that obesity health care expenditure in New Zealand is NZ\$303 million per annum.⁵ Further estimates indicate a saving of NZ\$25 million per year could result from a 5% increase in physical activity levels and that \$160 million each year could be saved if all New Zealanders were to become physically active to levels that afford health benefits.^{6,7}

As well as economic burden, obesity and physical inactivity have a significant impact on an individual's health and quality of life. Obesity and physical inactivity are two risk factors for a number of lifestyle related conditions including type 2 diabetes, coronary heart disease, hypertension, and some types of cancers.^{5,8}

By general consensus, participating in a minimum of 30 minutes of moderate intensity physical activity on most days of the week reduces the likelihood of developing these morbidities, and additional activity produces further health benefits. These findings are well summarised in the 1996 US Surgeon General's Report on Physical Activity.⁸ Despite the benefits conferred by regular activity, physical inactivity in New Zealand ranks behind smoking as the second highest modifiable risk factor for poor health, and is associated with 8% of total deaths.⁹

Targeting child and adolescent obesity is a health priority for several reasons. First, severe childhood obesity is associated with a diverse range of morbidities including orthopaedic problems, sleep disorders, menstrual abnormalities, insulin resistance, and psychological issues of early discrimination and victimisation.¹⁰ As well, persistence of obesity can lead to further long-term complications (including cardiovascular disease), and all cause mortality.¹⁰ Second, children and adolescents with severe obesity are at greater risk of obesity persisting into adulthood. Specifically, compared to childhood obesity status, adolescent obesity is a stronger predictor of adulthood obesity.¹¹

In addition to preventing obesity, the promotion of physical activity at an early age is beneficial for a number of reasons. Physical activity has been found to track over time,¹² and there is increasing evidence that regular physical activity among young people is associated with improvements in various health outcomes including blood lipid profile, blood pressure, body composition, glucose metabolism, bone strength, psychological health¹³ and the maintenance of normal growth and development.¹⁴

Recently developed New Zealand health policy documents highlight the need to address obesity and physical inactivity. For example, the Healthy Action – Healthy Eating Report,⁵ and the New Zealand Health Strategy¹⁵ state that obesity and physical inactivity are two of top four health priorities for New Zealand. Despite well-developed national policy documents, the national prevalence of obesity and physical inactivity for New Zealanders (especially New Zealand youth) is not clear.

The purpose of this paper is two-fold. First, the question 'Are New Zealand youth obese and physically inactive?' will be examined and methodological flaws of current research highlighted. Second, future research directions based on identified gaps within New Zealand youth obesity and physical activity research will be presented. The focus of this paper is on adolescents (aged 13–17 years old). Thus, the epidemiological evidence presented has been extracted from available data to ensure the focus is predominantly on people of this age range.

New Zealand obesity trends

Before examining the obesity trends, it is important to understand the measures of adiposity utilised in population level epidemiological research. Field measures of adiposity including body mass index (BMI), skinfolds, and girth measures are commonly used as screening tools because of their practicality, ease of implementation, cost effectiveness, and low participant and researcher burden compared to laboratory based measures.¹⁶

Although the International Obesity Task Force recommend BMI as an appropriate measure to use in epidemiological studies,¹⁷ several limitations of this method need to be considered. The most significant issue is that currently no agreed BMI cut-off thresholds exist to classify a child or adolescent as obese or overweight.

To date, different studies have used different cut-off thresholds based on different growth reference charts. This lack of consensus makes between-country comparisons difficult. Recently, however, the International Obesity task Force (ITOF) proposed international age-and sex-specific BMI cut-off thresholds based on pooled BMI data from six countries.¹⁷ Such definitions help develop international applicability and therefore ensure comparability of obesity rates between countries, however, they are still arbitrary and do not account for ethnic groups not considered in the population sample.

Ethnicity is an important factor when considering BMI definitions of overweight and obesity because the same BMI value does not correspond to the same percent body fat (%BF) across different population groups.^{18,19} Differences in the %BF–BMI relationship may exist due to differences in body build variables²⁰ such as slenderness, muscularity, and trunk-to-leg-length ratio.¹⁹

Recent New Zealand research indicates at the same BMI value, female children (aged 5–14 years) of Pacific Island and Maori descent have a lower percent fat mass compared to their New Zealand European peers.²¹ In another study using a larger sample size, however, no clinically significant difference in the relationship between BMI and body composition was found between young children (5–10.9 years) of Maori, Pacific Island, or European descent.²² Thus, further research clarifying the BMI - %BF relationship according to ethnicity among the New Zealand youth population is warranted.

Because of New Zealand's ethnically diverse population some New Zealand researchers advocate the development ethnic specific BMI cut-off thresholds. There are, however, several difficulties that arise when applying ethnic specific cut-off points, especially in a country like New Zealand where ethnic intermarriage is increasing, and with each generation reporting concurrent increases in proportion of children with a mixed ethnic background.²³

First, ethnicity is based on self-identity and not necessarily a genetic link. Second, in population level research identifying an individuals' ethnicity by means other than self-identity is difficult and not necessarily practical. As body build may account for a large proportion of the variation in the BMI–%BF relationship,¹⁹ adjusting BMI cut-offs according to frame size (rather than ethnicity) may provide a more accurate criterion to base BMI cut-offs upon.²⁴ Applying frame size based cut-off points, however, may be practically applied within a clinical setting, but not necessarily

within population level research due to the measures required to ascertain frame size (i.e. ankle and wrist girths).

Three national surveys have examined New Zealand youth obesity levels. The 1989 Life in New Zealand Survey,²⁵ and the 1997 National Nutrition Survey² examined obesity prevalence levels in youth aged 15 to 18 years old. Recently, the 2002 Child Nutrition Survey was conducted and provided a snapshot of the nutritional status (including BMI data) of children aged between 5 and 14 years old. No single survey has examined overweight and obesity among all adolescents.¹

Based on New Zealand ethnic-specific BMI cut off points, the National Nutrition Survey found 27% of 15 to 18 year olds were considered overweight or obese (see Table 1). Between 1989 and 1997 obesity levels rose from 3% to 12.6% in males, and from 2% to 5.3% in females. Therefore, over an 8-year period, obesity levels increased by 300% for males, and a 160% increase for females.^{2, 25} This comparison may under represent the true increase in overweight and obesity because the 1989 LINZ Survey used a lower BMI cut-off value (30 kg/m²) to define obesity among individuals of Maori and Pacific Island descent, compared to the 1997 NNS (32 kg/m²). Additionally, the New Zealand Child Nutrition Survey found 23% of children aged between 11 and 14 years old were overweight and a further 10.6% were obese.¹

Both the National Nutrition Survey and the Child Nutrition Survey found that a disproportionate number of Maori and Pacific peoples were considered overweight and obese compared to New Zealand European and Other children.^{1, 2} This may in part be due to the universal BMI definition used to define an individual as overweight or obese. This universal definition does not take into account body composition differences noticed among different ethnic groups within New Zealand. For example, Maori and Pacific Island females, on average, have a higher proportion of lean muscle mass at a similar BMI than New Zealand European females.²⁶

The prevalence of youth overweight and obesity in New Zealand is similar to other countries. Results from countries including Australia,²⁷ the United States,²⁸ Great Britain,²⁹ United Kingdom,³⁰ and Brazil,³¹ indicate that between 11 and 44% of youth are considered overweight or obese. In contrast, lower prevalence levels (around 7%) have been documented in Russia,³¹ China,³¹ and Finland.³²

In addition to the high levels noticed in many countries, studies indicate the prevalence levels are on the increase,^{29,33-36} and that the greatest changes have occurred at the higher BMI values.³⁷⁻³⁹ Also, similar to Maori and Pacific Island populations in New Zealand, specific ethnic minority groups including American Indians,⁴⁰ Mexicans,⁴¹ and Hispanic and African Americans⁴² are at an increased risk of being overweight or obese.

The global picture of youth obesity is clear. Obesity is a growing issue and is a health threat to the adolescent population and the future adult population. New Zealand is no exception, with high prevalence levels compared to some westernised countries.

Table 1. Adolescent obesity levels

Place	Survey	Age (years) / no. of children	Date of survey	% OW + OB
Brazil ^{*† 31,43}	Nationally representative surveys	10-18 / not stated	1975	3.7
	National Research of Health and Nutrition	10-19 / 13,715	1989	7.7
	Nationally representative surveys	10-18 / not stated	1997	12.6
China ^{* 31}	China Health and Nutrition Surveys	10-18 / not stated	1991	4.5
		10-18 / not stated	1997	6.2
East Germany ^{* 36}	Not stated	11-14 / 798	1992/93	8.92
		11-14 / 957	1995/96	12.82
		11-14 / 950	1998/99	15.85
Finland ^{* 32}	Adolescent Health and Lifestyle Survey	12,14,16,18 / 2832	1977	3.17
		12,14,16,18 / 8219	1999	7.64
Great Britain ^{‡ 29}	British Standards Institute Survey National Diet and Nutrition Survey	11-16 / 3784	1977/87	6.8
		11-16 / 776	1997	18.95
New Zealand ²⁵	Life In New Zealand Survey	15-18 / 676	1989	5 ^{††}
New Zealand ^{§ 2}	National Nutrition Survey	15-18 / not stated	1997	27
New Zealand ^{*1}	Child Nutrition Survey	11-14 / 1119	2003	33.6
Russia ^{* 31}	Russian Longitudinal Monitoring Survey	10-18 / not stated	1992	11.5
		10-18 / not stated	1998	8.5
UK ³⁰	The Health Survey for England	13-15 / 756	1996	44.3
United States ^{¶33}	NHES NHANES I NHANES II NHANES III	12-17 / 6710	1963-1970	15.15
		12-17 / 1911	1971-1974	17.3
		12-17 / 1970	1976-1980	15.9
		12-17 / 1103	1988-1994	21.45
United States ^{** 42,44}	Youth Risk Behaviour Survey	13-16 / 13,601	2001	24
		13-16 / 15,214	2003	28.9

OW=overweight; OB=Obese; *Defined overweight and obesity as a BMI \geq 85th centile for BMI by age and sex based on reference data from international reference data¹⁷; †The OW+O was defined from a body mass index (BMI) equal or superior to the 85th percentile of the reference population of the NCHS; ‡Defined overweight as a BMI value 91st percentile and obesity as a BMI value 98th percentile on the 1990 BMI index reference curves for UK. §Defined overweight and obesity as a BMI \geq 25 kg/m² for New Zealand Europeans, and a BMI \geq 26 for Maori and Pacific Island peoples; ||Defined at risk of overweight and overweight as a BMI \geq 85th percentile for BMI based on UK reference data; ¶Defined overweight and obesity as a BMI \geq 85th percentile for BMI by age and sex based on reference data from National Health Examination Survey (NHES) II & III; **Defined at risk of overweight and overweight as a BMI \geq 85th percentile for BMI by age and sex based on reference data from CDC growth charts; ††Obesity data only.

Physical activity

Physical activity is an important lifestyle behaviour that impacts positively on both the prevention and management of obesity. Before physical activity prevalence data are examined, it is important to understand the measures and definitions used in large-population physical activity research. A number of objective, and subjective methods exist to measure physical activity. Population research has relied heavily on subjective measures of physical activity such as questionnaires, (e.g. self report, proxy reports, interviews). Although questionnaires are cost effective, easy to implement, and have a low researcher and participant burden, issues of recall bias, social desirability, and deliberate misrepresentation may make interpretation difficult. Also, proxy reports which are often used, provide limited validity when measuring subjective matters such as physical activity.⁴⁵

A limitation of adolescent physical activity research is that currently no standardised physical activity recommendations exist for the adolescent population. The lack of such a recommendation impacts on the ability to define an individual as active versus inactive. Although physical activity guidelines have been proposed,⁴⁶ several studies have examined different durations (e.g. 30 minutes per day, 60 minutes per day, 150 minutes per week), intensities (e.g. moderate, vigorous), frequencies (e.g. five days per week, every day), and type (e.g. incidental, transportation, school related, sport) of physical activity. This increases the difficulty in making between-country comparisons.

In New Zealand, physical activity data relating to age, sex, and ethnicity of adolescents have been collected through several surveys, including the New Zealand Health Survey,⁴⁷ the Youth 2000 Survey,⁴⁸ National Children's Nutrition Survey,¹ and the main physical activity monitoring system, namely, the Sport and Physical Activity Surveys.³

Sport and Recreation New Zealand (SPARC) has been a world leader in examining New Zealand physical activity and inactivity trends by implementing the Sport and Physical Activity Survey (SPAS), a comprehensive physical activity surveillance system. To date, SPARC has carried out the SPAS at three time points, 1997/98, 1998/99, and 2000/01.³ The combined results of the three SPAS's indicate that 37% of New Zealand adolescents aged 13 to 17 years are physically inactive (i.e. they did not participate in a minimum of 150 minutes of physical activity per week). Also, compared to Maori and Europeans, Pacific peoples, and people from other ethnic groups were considered least active.³

By comparison, young people in New Zealand appear relatively active to their peers in countries such as Canada,⁴⁹ and England.⁵⁰ In contrast, only 31% of adolescents (Grades 9 through 12) in the United States were classified as 'insufficiently active' in 2001⁵¹ which is similar to levels noticed in New Zealand. In Table 2, adolescent physical activity statistics from various countries are presented.

Comparing physical activity data sets from different countries, however, is often difficult because of differences in measures and criteria for defining an individual as 'sufficiently' active. Adolescent data sets are no different. The New Zealand definition of being physically active for youth is less strict compared to definitions in other countries. For example, in Canada, young people are required to achieve energy expenditure =8kcal/kg body-weight per day (KKD). This equates to 1 hour of

moderate physical activity and 30 minutes of vigorous activity per day. Based on this definition, 65% of 13–17 year old Canadians are considered inactive.⁴⁹

When countries have applied similar definitions of ‘physically active’ utilised by New Zealand, in fact, rates of inactivity are comparable. One such example is highlighted in the Health Survey for England. When the criterion employed changed from 60 mins of physical activity per day to 30 minutes per day, the level of inactivity decreased from 62.7% to 42.3%⁵⁰ which is similar to the level noticed among New Zealand youth.³

Table 2. Adolescent physical inactivity levels

Place	Survey title	Age	Date of survey	Percent	Definition
Canada ^{49,52,53}	Physical Activity Monitor	13-17	1995	64	Did not achieved Energy expenditure =8kcal/kg body weight per day (KKD)
		13-17	1998	66	
		13-17	1999	59	
		13-17	2000	65	
England ^{50,54}	Health Survey for England	13-15	1997	62.7	Did not participated in 60 minutes or more on at least 5 days
			1997	42.3	Did not participated in 30 minutes per day over the past 7days
	Health Survey for England	2-15	2002	25.5	Did not participated in 30 minutes per day over the past 7days
New Zealand ³	Sport and Physical Activity Survey	13-17	1997-2001	38	Took part in < 2.5hr of physical activity in the previous 7 days
United States ^{44,51}	Youth Risk Behavior Survey	13-16	2001	35	Did not participate in sufficient vigorous physical activity
			2003	37.4	
			2001	74	Did not participate in sufficient moderate physical activity
			2003	75.3	
			2001	31.2	
2003	33.4	Did not participate in vigorous activity AND did had not participate in moderate activity			

Despite the difficulty in making direct comparisons between countries, several trends have emerged from the SPAS that are noticed worldwide. Three trends that emerged from the SPAS are (1) physical activity levels decrease from childhood to adolescence, (2) physical activity levels decrease during adolescence, and (3) females are more physically inactive than males (45% and 33% respectively).

Similar trends have been found for youth in England,⁵⁰ Australia,⁵⁵ and Canada.^{49,52,56} Data pertaining to the United States shows that participation in either moderate or vigorous activity decreases with increasing age,⁵¹ physical activity patterns generally decline most from ages 15 through 18, and then continue to decline from 18 to 29 years of age.⁵⁷ As well, males compared to females, and Whites compared to their Hispanic and Black counterparts, participate in significantly higher levels of moderate and vigorous physical activity.⁵¹ For example, in a recent Canadian survey, physical activity levels were higher among children aged 5 to 12 years compared to youth aged 13 to 17 years.⁴⁹

The main advantage of the current SPARC physical activity surveillance system is that regular monitoring has taken place. Four limitations, however, exist which impact on the efficacy of this survey. First, the existing surveillance system has been based largely on parental proxy report. Proxy reports require an adult (aged 18 years or older; living in the same house as the child) to report on the child's habitual activity levels. Proxy reports have little correlation with more direct measures of physical activity.⁴⁵ Second, the Sport and Physical Activity survey has not been validated for the population under study. As well, the previous surveys carried out by SPARC have focused predominantly on sport and exercise rather than physical activity *per se*. Finally, the quantity of physical activity required to define a youth as physically active in the New Zealand survey is substantially lower compared to other countries and is not in line with proposed physical activity guidelines for children and adolescents.⁴⁶

Hence, the positive picture of New Zealand youth physical activity levels may largely be an artefact of the existing surveillance system, and, therefore helps explain the considerably lower prevalence levels of inactivity in New Zealand youth compared to youth in other countries. By building upon and overcoming these methodological flaws of the existing surveys, a more accurate and reliable picture of the health-related physical activity patterns of New Zealand youth will emerge.

Although the main focus of this paper is on obesity and physical inactivity, diet is also a key determinant of obesity. Despite epidemiological evidence indicating a stability,⁵⁸ and in some instances a decrease in energy intake,⁵⁹ such research also provides insight into the changes in eating patterns that have occurred simultaneously with the increasing rates of youth obesity. Specifically, there has been a shift towards consuming more energy intake from restaurants and fast food places compared to home sources of food,⁶⁰ an increase in energy dense foods including pizza, cheeseburgers, and salty snacks,⁶⁰ as well as a greater proportion of energy consumed from sugar added beverages.⁵⁹

When examining the link between dietary behaviours and obesity, recent research suggests particular eating patterns and sources of dietary intake are important factors associated with youth obesity. United States data indicate overweight youth consume a greater proportion of total energy intake from soft drink consumption compared to

their non-overweight peers.⁵⁸ Skipping breakfast has also been associated with overweight cross sectionally⁶¹, and with an increase in BMI among normal weight youth over time.⁶¹ Furthermore, a greater frequency of eating food purchased away from home was positively associated with change in BMI z-score during adolescence.⁶²

In terms of New Zealand specific data, the New Zealand Child Nutrition Survey provided an extensive examination of nutrition intake and dietary behaviours among New Zealand children aged 5 to 14 years old. Analysis of such data in relation to BMI are not yet published.

A difficulty in assessing the importance of lifestyle behaviours in the aetiology of obesity is that obesity occurs over time while many measures of lifestyle habits occur once the obese state has been reached. For instance, a recent study found that (over a 1-year period) skipping breakfast was associated with a decrease in BMI among overweight children, while normal weight peers who skipped breakfast gained weight over the same time period.⁶¹

Thus to provide an accurate assessment of factors associated with youth obesity in New Zealand, surveillance of diet must occur concurrently with that of obesity and physical activity.

Where to now for New Zealand?

Youth obesity and inactivity are two growing health problems worldwide. Because obesity and physical inactivity have been identified in the top-four health priorities for New Zealand,¹⁵ as a country we need to monitor and characterise these risk factors in terms of prevalence, distribution, and secular trends. For this to occur, an enhancement of existing national surveys is required. Such surveillance is essential to identify at-risk groups, inform public health policy, develop appropriate and effective prevention and management initiatives, and track progress toward national health priorities.

In terms of youth obesity, the recent Child Nutrition Survey¹ has overcome the paucity of data pertaining to obesity levels of young people aged 14 years and younger. Future research needs to ensure (1) regular monitoring of obesity levels among adolescents and adults, and (2) development of age, sex, and ethnic specific BMI cut-off thresholds to define overweight or obese.

In relation to physical activity, improving the current surveillance system would involve the validation of a youth physical activity questionnaire, establishing physical activity recommendations for youth based on international best practice, and incorporating a more holistic view of physical activity that includes health-related activity accumulated in activities such as active transportation and part-time work. Overcoming these issues will result in an enhanced physical activity monitoring system capable of providing an accurate and holistic assessment of youth physical activity levels.

Finally, attention needs to be directed towards identifying correlates of obesity and inactivity among different cultures and socioeconomic groups. Literature indicates numerous biological, behavioural, and environmental factors are linked to the development and maintenance of obesity. A systematic review⁶³ found that risk factors for childhood obesity included parental fatness, social factors, birth weight,

timing of maturation, physical activity, dietary factors, and other behavioural and psychological factors. In terms of behavioural factors, time spent watching television,^{4, 64-66} and physical activity (inverse),⁶⁷⁻⁶⁹ eating lunch regularly⁷⁰ breakfast skipping,⁷¹ and quick service food purchases⁶² have all been associated with obesity status.

In New Zealand, however, no published research has examined such factors among New Zealand youth according to gender and ethnicity. Future research examining the factors associated with obesity and physical activity among New Zealand youth will provide a foundation of knowledge to inform the development of multisectoral, multisetting, and sustainable health promotion initiatives aimed at reducing the prevalence of obesity and inactivity among New Zealand youth.

But first we must have a real picture of the status of our adolescents in terms of both overweight/obesity and physical inactivity—only then will we have a basis on which to build effective interventions, and monitor the success of such interventions.

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Acknowledgements : Maea Hohepa acknowledges the support of the New Zealand Health Research Council and Auckland University of Technology who provided resources to complete this article. The research was conducted during her tenure as Maori PhD Scholarship recipient of the Heath Research Council of New Zealand.

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Appendix Z: Physical Activity: What do High School Students Think?



Journal of Adolescent Health 39 (2006) 328–336

JOURNAL OF
ADOLESCENT
HEALTH

Original article

Physical Activity: What Do High School Students Think?

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Manuscript received September 22, 2005; manuscript accepted December 22, 2005

Abstract

Purpose: To explore the views high school students have about various physical activity contexts and their ideas of potential physical activity promoting strategies.

Methods: Forty-four students from New Zealand high schools with a low decile rating participated in one of nine focus groups. All groups were separated by gender and ethnicity (Māori, New Zealand European). A standardized semi-structured schedule that included key questions and prompts was used. Thematic induction of the raw data was conducted using the long table approach.

Results: Perceived benefits of physical activity participation centered on fun, achievement, and physical-related factors. Key barriers to physical activity engagement included lack of peer social support and low accessibility to, and availability of, physical activity opportunities. The structure of physical education (PE) classes was a barrier noted by females. Distance was consistently articulated as a barrier to commuting actively to school. Reflective of the barriers raised by participants, self-identified strategies to promote physical activity participation included environmental modifications such as (1) increasing social support from peers, (2) improving availability of, and accessibility to, activities at school and in their neighborhood, (3) providing organized activities at school, and (4) restructuring physical education classes.

Conclusion: In line with the current understandings of barriers to physical activity participation, youth perceptions were focused toward environmental factors, both social and physical, thereby supporting further development of environment-focused interventions. The potential of the peer, school, neighborhood, and home strategies reported in our study need to be considered in future initiatives targeting youth physical activity. © 2006 Society for Adolescent Medicine. All rights reserved.

Keywords:

Physical activity; Youth; Perceptions; Barriers; Benefits; Strategies

During adolescence, physical activity is acknowledged to play an important role in the prevention of obesity [1,2], and in health promotion in general [3]. As in many countries [4,5], inactivity is prevalent among the youth population in New Zealand [6], which has likely supported the burgeoning obesity epidemic [7]. More research aimed at understanding how to increase physical activity behaviors of youth is therefore necessary. Consulting with and engaging

high school students in the development phase of interventions has the potential to improve the efficacy of future efforts aimed at combating health issues faced by youth, including inactivity.

Previous research has explored the perceptions children [8–10] and adolescents [8,11–17] hold about physical activity participation, particularly in relation to the perceived barriers and benefits. Activity contexts such as active transportation, structured sport, and physical education (PE) are now considered important opportunities through which youth can achieve their daily activity dose. To our knowledge, the examination of youth perceptions toward various activity contexts, with the exception of physical education, has not been examined among high school students.

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As a consequence of research exploring perceptions about physical activity, potential strategies for promoting physical activity are often cited from a researcher perspective, with little involvement from the target population (the youth themselves). Only three studies have examined potential activity-promoting strategies as part of a focus group discussion with youth [8,12] or children [9]. Studies reported a strong focus toward environmental strategies that targeted young people's home, school, and neighborhood environments.

The available literature regarding youth perceptions of physical activity must be considered in light of several limitations. First, questionnaires are frequently used to examine perceptions, limiting the findings to a list of predetermined and possibly biased perceptions. Second, perceptions of teenagers are often examined in terms of physical activity in general, with little exploration of perceptions around specific activity contexts (structured sport, active transportation, physical education classes). Third, few studies have examined gender- or ethnic-specific perceptions.

The aims of this study are threefold. To explore, according to gender and ethnicity, high school students' perceptions regarding (1) the benefits of physical activity, (2) the barriers to participating in various activity contexts (e.g., active transportation, PE, lunchtime activity), and (3) potential activity promoting strategies from an ecological perspective.

Methods

Sample

A convenience sample of high school students from three schools situated within metropolitan Auckland, New Zealand were approached to take part in this study. The schools were matched in terms of socioeconomic status using the school decile rating, a proxy for socioeconomic status ranging from 1 (most deprived) to 10 (least deprived). Each school involved had a decile rating of 2, indicating low socioeconomic status. Depending on the school, the proportion of Māori students on the school roles varied from 20% to 100%, whereas New Zealand European students comprised between 0% and 37% of the school roles [18–20]. A teacher at each school was approached to nominate approximately 24 students from Year 9 and 10 (13–15 years old) who varied in activity level and who identified themselves strongly as either Māori (indigenous people of New Zealand) or New Zealand European. In total, 44 participants took part in focus group discussions, 24 females and 20 males. Māori participants comprised just over 50% of the female ($n = 13$) and male ($n = 11$) sub-samples.

Focus group procedure

A total of nine focus group sessions were conducted on school premises at a time suitable for both the school and

Table 1
Core questions for focus groups

1. What are some of the benefits of participating in physical activity for you and other young (Māori/New Zealand European) people?
2. Why are you and other young (Māori/New Zealand European) not physically active?
3. What could be done to help you and other young (Māori/New Zealand European) people be more physically active during (school, weekend, after school, getting to school)?

the participants. The focus groups were separated according to ethnicity (Māori and New Zealand European) and gender, and included a maximum of six participants (range 3–6) in each group. Focus groups sessions lasted approximately 50 minutes. All focus groups were conducted by the primary author, who has experience with high school youth through extensive coaching experience and who is currently undertaking doctoral studies in the area of youth obesity and physical activity. Two Masters level students were recruited to take notes during each session. The study was approved by the Auckland University of Technology Ethics Committee. Consent was obtained from a school authority, and assent and consent from each participant and their parent, respectively.

Focus group schedule

Focus group discussions were based upon a standardized semi-structured interview schedule. General areas included in the schedule were (1) perceived benefits of physical activity, (2) perceived barriers to various activity contexts (e.g., structured sport, active transportation, physical education classes), and (3) potential strategies to increase physical activity levels of high school students. The focus group schedule included broad open-ended questions to elicit as wide a range of responses as possible. Content and face validity of the schedule were assessed during the development stage of the interview schedule. Experts in the field of qualitative research examined the schedule to ensure appropriateness in terms of question structure and schedule length, while physical activity experts reviewed the content of each question. As a result of this process the schedule was downsized to include three key questions, as outlined in Table 1.

For each question, a set of probes was developed to be used to generate discussion. The four probes for Question 1 were social benefits, physical benefits, sport performance benefits, and psychological benefits of being active. The probes for Question 2 surrounded various activity contexts, including active transportation, lunch break activities, physical education classes, after school, and weekend physical activity. For Question 3, an ecological approach was used to examine potential strategies for increasing activity levels of young people. A key aspect of taking an ecological approach [21] is to examine potential strategies from an individual and an environmental perspective. To achieve this,

Table 2
Perceived benefits identified by high school students

Major themes	Sub-themes	Comments
Fun	Game quality	"Just the games that we play"
	Socializing	"Cos it is fun playing with your friends"
Achievement	Aspirations	"So you can go onto better things like the All Blacks" "committed to our sport", "so you can be better at it"
	Social recognition	"Say you are really good at sports and you achieve something they might say something at assembly and people will get to know you"
	Self-development	"Learn new skills", "... to get better at it (sport)"
Physical benefits	Appearance	"Makes you feel skinnier . . ." "Keeps yourself looking good"
	Physical performance	"Build up your upper strength, hits in rugby" "Stronger and quicker"
	Health benefits	"Do swimming for my breathing" "Helps asthma, it develops your lung, . . ." "If you get fat . . . more chance of getting heat disease"
Psychological benefits	Mood	"just feel better about yourself" "like if you win a game you feel good but then if you lose you feel real stink and that you suck" "calms me down, release anger"
	Confidence	"..in your first game your not confident, . . . it will be like that was cool so you keep playing and playing because you are confident in yourself" "Makes you want to try new things, expand on new sports..." "you know what you are doing and you don't need to hide"
Preferential activity	Best available option	"Don't have to look after by brothers" "Get away from mum she makes me do work chores" "There's nothing else to do"

Question 3 was framed to ask how they could help themselves be active and how their family, school, and neighborhood could also help them be more active.

Focus group analyses

In addition to the note taker, all focus group discussions were audio-taped to ensure that all discussion points were captured. Thematic induction using the long table approach [22] was employed to analyze the content of the transcribed manuscripts and notes obtained during the focus groups. The long table approach involved positioning a hardcopy of each quote under its respective question heading. Under each question heading, like comments were grouped together. The extensiveness, emotion, and specificity of the quotes were considered to help determine common, dominant, and significant themes inherent in the raw data.

Results

Perceived benefits of participating in physical activity

As highlighted in Table 2, benefits centered on five major themes relating to fun, achievement, physical, psychological, and preferential activity factors. Participant quotes supporting each theme are also included in Table 2. Fun

emerged as a benefit that was a product of the socialization aspect of physical activity (e.g., "hang out with friends"). For males, extrinsic achievement factors, including social recognition of their abilities by peers and aspirations for higher achievements, were articulated. For females, winning was an extrinsic benefit, however, intrinsic benefits were also communicated (e.g., learning new skills). Another gender difference arose regarding physique-related benefits. Although both genders articulated appearance-based benefits, for females, this related to "feeling skinnier" and "not fat," whereas males expressed more physical performance benefits (e.g., stronger and faster).

Psychological benefits were identified as a reason to be active but were less important than other themes identified. Males expressed activity as a cathartic experience for releasing anger and achieving a state of calmness. Females, but not males, indicated physical activity participation can result in a "confidence boost," which in turn can also help young people "try new things" and "expand on new sports you haven't tried before." Irrespective of gender, physical activity was a preferential option over other social responsibilities, including doing chores or looking after siblings, and was considered an option when there was nothing else to do.

Table 3
Perceived barriers identified by high school students

Major themes	Environment	Sub-themes	Comments
Supportive sedentary environments	Home	Electronic devices	"talking on the phone" "listening to the radio"
		Passive transportation	"Watching television" "Your friend's family is driving down the road they will stop and pick you up". "There is always a car to get dropped off in" "If you can do those things like catch the bus why would you want to walk I wouldn't want to".
	School	Accessibility and availability	"nothing to do at lunchtimes" "Because the school doesn't lend the equipment"
Peer influences	Friends	Lack of peer support	"My friend just wants to sit down and listen to music", "Sometimes your mates just don't want to [play] no point in playing"
		Social belonging	"If you're not up with playstation games or computer games or watch the newest programme you don't know what they [other students] are talking about" "If you don't socialise you will be antisocial and no one will like you"
		Perceived Incompetence	"People in teams are better than us, higher than us, will show us up" "... don't want to play because you think you are going to let the team down".
Structure of physical activity opportunities	School	Sport	"Don't want to be shamed out [when trialling]" "Teams are graded not just for fun just put the good people in it" "People take it to serious" "Nah there are only a certain number that get chosen for it that is why not most people go and join sports because of that...trials"
		Physical education	"The way we do it (activities in PE classes) is stupid because everyone watches you and then laughs" "Some people don't share like the boys in our class" "Tell the teachers not to make use do running"
Physical constraint	Neighborhood	Distance	"I would have to walk to school from Mangere bridge" "Live far away easiest way [by car] to get to school" "If you can do those things like catch the bus why would you want to walk I wouldn't want to" "Too far ... there is like hills and everything so I am not going to walk" "Too far to walk [to school]" "It's 11 km from my house to the bus stop and I catch a bus to here [school] so I can't walk"
		Safety	"Lots of hood rats down my street" "Some of them walk around in gangs makes you want to hurry up and get home" "Parks—only safe in some parts"
Motivation level	N/A	Low motivation	"can't be bothered"
Lack of time	Home, school	School, home, and work-related duties	"Get up late won't have time [to walk to school]" "Take too long to shower in the mornings" "No time to do it all"

Barriers to participating in physical activity

Table 3 shows the themes that emerged around the barriers to participating in physical activity and quotes related to individual themes. Participants portrayed a sedentary lifestyle and preference toward sedentary activities that transcended across

various environments. Families provide easy access to sedentary activities, and passive transportation modes, while schools restricted access to the use of sporting equipment and the gymnasium at lunchtime, which underpins young people's belief that there is "nothing to do at lunchtimes."

Of the activity opportunities that are available at school, female participants' highlighted structure-based barriers surrounding sport participation and PE classes. Trialing for sport teams, the seriousness of participation, limited team numbers, and the lack of social teams were reported barriers to sport participation. Barriers to PE, at least for New Zealand European females, included a dislike toward performing activities in front of other class members singularly. Also, for females, perceived incompetence and perceptions of peer judgments were noted as barriers, which in turn inhibited involvement in PE classes and trialing for sport teams (e.g., "People in teams are better than us, higher than us, will show us up")

Peer influences also negatively affected participation in general. Lack of interest from friends to be active, absence of people to be active with, and expectations to partake in passive socialization during lunchtime were reported barriers. Social belonging was a peer-related barrier articulated by New Zealand European males who stated that "If you're not up with Playstation games or computer games or watch the newest programme, you don't know what they (other students) are talking about" and that "If you don't socialize you will be antisocial and no one will like you."

Barriers surrounding active transportation to school were predominantly physical in nature, including travel distance, lack of time, and to a lesser extent, safety-related concerns, especially for females. Lack of motivation to actively commute was also expressed, considering other passive modes are readily available (e.g., "There is always a car to get dropped off in").

Physical activity-enhancing strategies

The strategies identified to enhance physical activity are summarized in Table 4. Two of the three strategies were related to environmental factors. Both physical (e.g., accessibility, availability) and social (e.g., social support) aspects of the participants' proximal environment were noted. The third strategy related to individual approaches.

Greater accessibility to, and availability of, activity opportunities at school, and to a lesser extent, around the neighborhood, were reported as possible strategies to increase physical activity. In addition to structured sport, more fun-based activities could be held during both the school day and after school. Females, in particular, expressed the need for "more sports teams" and the wish that, in addition to traditional sports like rugby and soccer, "a wider range of sports could be offered." Greater access to sporting equipment at school during lunchtime and implementation of organized activities at lunchtime and after school were also suggested. Modifying the current PE curriculum was another school-based strategy recommended. Suggested modifications, however, were gender specific. Male participants recommended "more PE classes" per week and the potential for "PE homework." Females, how-

ever, alluded to the activities conducted within PE classes, suggesting certain activities should be excluded (e.g., fitness, running) and that teachers could involve students in the decision-making process of choosing specific activities for the session. Female participants also felt teachers could "teach you how to (play) so you can have fun and you know what you are doing."

Neighborhood modification referred to developing more activity locations, for instance, "parks," "basketball courts," "bike tracks," and "rock climbing walls." A female participant, who resided in a rural location, also suggested "more sidewalks." Creating more neighborhood-based "fun days" was also suggested by New Zealand European female participants.

Participants also expressed the need for more support in the form of encouragement and/or involvement from their friends and family. For females, joining a team with a friend could overcome barriers related to lack of support (e.g., "...you can both enter in a team, then you would know someone there, you might not want to join because you don't know anyone") and low perceived competency ("If you do something wrong. . . [they are] laughing with you not at you"). Friends could also provide encouragement by providing guidance on how to play the sport. To a lesser extent, parent-based approaches, including more logistical support, encouragement, and parental policies, were suggested. Logical support included providing transportation to activity locations, and being more involved with enrolling their children in physical activity programs or teams. Male participants indicated parents could "push" them to be more active as a form of encouragement. Lastly, changes in parental policies that focus on limiting television watching could also be implemented.

Participants also expressed self-responsibility-focused strategies, in that being active was determined in part by their actions to be involved with existing activities, but also how they could fit activity into their daily lives. Partaking in active transportation (e.g., running or biking to school), organizing sport teams with classmates, and bringing their own equipment to school were suggested. Getting up earlier to walk to school, although considered, was not believed to be a viable option. One female participant acknowledged her awareness of pedometers and how she found it useful in setting daily step-based goals.

Discussion

Consistent with previous research [8,12,13], high school students in metropolitan Auckland verbalized several benefits of being active, including having fun, social recognition, socializing, and meeting new people. New Zealand youth also acknowledged physical activity as a preferential behavior over home responsibilities (e.g., doing chores or looking after siblings) but not over recreational sedentary alternatives (e.g., television watching). This suggests that

Table 4
Potential physical activity promoting strategies identified by high school students

Major theme	Environment	Sub-theme	Comments		
Availability and accessibility	School	Create more activities	"more sports teams"		
			"Need fun activities. Make it look like they want to join"		
			"Have more fun day type things not sport days"		
		Modify the PE curriculum	"Wider range of sports like instead of just doing the main ones like soccer or rugby or volleyball"		
			"Having more activities around the school"		
			"Don't do fitness . . . I hate doing fitness just like doing the sport"		
		Logistical support	"Ask us what we like first"		
			"[PE teachers could] teach you how to do [play] and so you can have fun and you know what you are doing"		
			"More PE" "Could get PE homework"		
			"Give out sports gear (at lunchtime)"		
Neighborhood	Modify the physical environment	"..games . . . arranged"			
		"Put out games and balls"			
		"Set up activities"			
		"Parks"			
	Create more activities	"Basketball court"			
		"Bike tracks"			
		"Rock climbing [wall]"			
Peer and familial support	Friends	Peer involvement	"There is no where to ride your bike the closest arena . . . is about 20 minutes away, 10 minute drive 20 minutes to walk"		
			"Fun days"		
			"Have fun little sports days . . ."		
			Peer encouragement	"[friends] can come and play its boring by yourself"	
				"My class made up an indoor cricket team last year that was good"	
				"Well if they [a friend] joins a team you might want to join with them you can both enter in a team then you would know some one their you might not want to join because you don't know anyone"	
			Home	Logistical	"If you do something wrong ..[they are] laughing with you not at you"
					"Helps to have someone to go with you if you wanna go for a run . . ."
					"Could encourage you to get into teams"
					"Can help you learn new skills . . . well say they had played longer than you and you've just started they can like give you tips and pointers of how to play the sport"
Parental policies	Encouragement	"Sign you up for activities"			
		"Taking us out to places more . . . beaches, pool, gym"			
		"Get you in some teams or ask you what sports you like"			
		"Could push us to do more sports or why don't you join this"			
Self-responsibility	N/A	Self-reliance	"They [parents] could ask you what sports you like"		
			"Cut off the TV"		
			Motivational Assistance	"Run home"	
				"Ride to school"	
				"Join a sports team and if you don't like that just join another one"	
		"Bring [to school] rugby ball to play with stuff that you can protect"			
		"My class made up an indoor cricket team last year that was good"			
		Motivational Assistance	"Go for a daily run"		
			"Play sports"		
			"Get up earlier to walk to school"		
"Pedometers"					
"I'd set my self a goal for how many steps and . . . try and beat that everyday"					
"Be confident with what you are doing"					

N/A = Not applicable.

physical activity is not always the highest priority in young people's lives. This finding is not surprising considering their immediate environments (e.g., friends, school, home,

neighborhood) were found to be encouraging of a sedentary lifestyle through a perceived lack of social and/or physical support, making healthy choices difficult.

Many of the barriers and potential strategies identified were related to high school students' perception of choice. Youth choices were compromised at school because of poor accessibility to, and availability of, activity opportunities at school lunchtime (e.g., limited access to sports equipment and the school gymnasium during lunchtime). Like a previous qualitative study with children aged 10 to 13 years [9], improving the choice of activity opportunities was a motivating factor influencing participation. In our study this referred to increasing accessibility to sport equipment, more organized activities, a greater number of sport teams, and a wider variety of sports or other activities as well.

Similar to Wilson et al [9], increased choice also extended to PE classes. Participants expressed interest in being involved in decision-making processes during PE classes to determine the activities to be undertaken. This strategy could be reflective of adolescence, a period characterized by an increase in independence [9]. Increasing the weekly number of PE classes was also suggested. This strategy is supported by recent studies that found elementary [23] and secondary school students [24] achieved higher activity levels on school days that included physical education compared to those days without PE classes [23]. Research examining the feasibility of providing a PE environment that incorporates student-driven activities, with the appropriate physical (e.g., variety of activities) and social support (e.g., encouragement for teachers and peers) elements is, therefore, warranted.

Peers also influence young people's choice to participate in physical activity. Supporting this perspective, a recent study of high school-aged females [25] found that peers exhibiting a reciprocal friendship demonstrated a stronger correlation in activity behaviors (as measured by pedometry) compared to students in non-reciprocal friendships. Our findings provide further support for the strong influence of friends on young people's physical activity behavior, in that friends could either impede participation or be a potential supportive source of activity through verbal encouragement and role modeling. Although peer influences such as encouragement have been examined cross-sectionally, and shown only to be weakly correlated with global activity levels [26], friends may exert a stronger influence on context-specific activities such as sport participation and lunchtime physical activity. Furthermore, compared to parental influences, peer influences were articulated to a greater extent, which supports previous research suggesting that peers are a greater source of influence during adolescence [27].

Active commuting to school is a key strategy to help youth achieve their daily activity dose. Like previous research [28], however, our study found distance to be the main barrier impeding youth actively commuting to school. Distance, however, was compounded with families (both their own and their friends) having automobiles readily

available for passive transportation. This, in turn, could likely influence young people's lack of motivation to walk or bike to school, or to wake up earlier to overcome time constraints associated with active commuting.

In addition to school and peer influences, the findings also show that neighborhood factors (safety and accessibility to activity locations) influenced activity behaviors. Further exploration of environmental influence of youth activity behavior is warranted, considering that a recent nationally representative survey of New Zealand high school students reported that regular vigorous activity was negatively associated with safety concerns, while accessibility to activity locations increased the likelihood young people would be physically active [11].

Gender differences were apparent among participants, with females acknowledging structure-related barriers to participating in sport teams and PE classes. Considering that physical activity levels of adolescent girls decline during high school years [15], providing positive experiences in such activities at school may assist in offsetting this trend. Modification of current legislative school policies regarding physical education classes and other school activity opportunities (e.g., more sport teams) is justified to ensure optimal engagement of students, both males and females, and those sport or not so sport minded, in active movement. A suggested strategy acknowledged in previous studies was same-gender physical education classes [8,16] and physical activity programs [9] in general.

Both Māori and New Zealand European participants reported similar benefits, barriers, and potential strategies. Based on these results, the perceptions from which interventions can be based seem to be consistent across both Māori and New Zealand European cultures. Because all participants attended low decile schools, the commonality of their socioeconomic status (based on school decile rating) likely supported the congruence of perceptions between the ethnic groups. To further examine potential disparities in perceptions according to ethnicity, focus groups, including participants of various socioeconomic levels, could be conducted. Future research, however, should also examine perceptions according to socioeconomic status, because this has been shown to influence perceptions among the adult population [29].

Although our study explored various activity contexts, it was evident from the group discussions that high school students perceived sport and physical activity to be synonymous terms. As a result, many of the reported findings are in relation to their thoughts about sport rather the physical activity per se. This observation is not surprising considering school physical education is sports driven and that parents are likely to portray this perspective as well. It is therefore not surprising that the strategies identified were very sport oriented. More focus toward providing youth with a greater knowledge about more general forms of

physical activity and diverse modes of being physically active is, therefore, warranted.

To help enhance physical activity levels among the youth population, a diverse range of strategies that transcended various environments including the school, neighborhood, peer and home settings were suggested by the participants. This finding highlights the need for future interventions to incorporate a multi-strategy and multi-environment approach to enhance physical activity levels among teenagers. A coordinated approach among local authorities, government agencies (e.g., Ministry of Education), schools, families, and neighborhoods is therefore required to address policy, physical, and social-related strategies that were verbalized.

Strategies employed, however, should be individualized to the target community because appropriate strategies will likely differ according to community location (rural vs. urban setting), target population (male vs. female) and the community needs (i.e., what activity opportunities or activity-promoting infrastructure is lacking?). In terms of gender, gender-specific physical education classes and allowing student input in determining the content of PE classes may help ensure that PE provides a more positive physical activity experience, especially for females. Although some strategies did differ between genders, such strategies could potentially be applied to both genders (e.g., having a wider variety of sports available at school, not having to travel for sport teams).

Our study builds upon previous research by examining young people's perceptions toward specific activity contexts, as well as exploring their thoughts regarding potential strategies aimed at enhancing activity behaviors. In addition, our methodology allowed the examination of gender- and ethnic-specific barriers, which has been lacking in previous research. To the knowledge of the authors, only one other study has examined perceptions toward physical activity among New Zealand high school students [11]. Although based on nationally represented data set [30], only perceived benefits were determined using survey methodology, thereby, limiting responses to a pre-determined list of benefits.

Some potential limitations within this study need to be noted. The use of focus groups, and restricting participant demographics to certain school levels (Year 9 and Year 10) and specific ethnic groups (Māori and New Zealand European) limits the generalizability of our findings to other young people. Also, the generic demographics of groups do not allow examination of the perceptions according to weight status or activity level. Additionally, the sample was one of convenience and included only schools with a low decile rating.

Conclusion

The importance of environments on health behaviors such as physical activity is gaining momentum and at-

tention from researchers, policy makers, and local authorities. Our findings provide further support for developing environment-focused strategies to increase physical activity participation of youth in various activity contexts (PE, active transportation). Also, when developing strategies, the needs of both females and males need to be considered.

Acknowledgment

Maea Hohepa acknowledges the support of the Health Research Council of New Zealand and Auckland University of Technology for the resources to complete this article. The research was conducted during tenure of a Māori Ph.D. Scholarship from the Health Research Council of New Zealand.

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Appendix AA: Social support for youth physical activity: Importance of siblings, parents, friends and school support across a segmented school day

International Journal of Behavioral Nutrition and Physical Activity



Research

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Social support for youth physical activity: Importance of siblings, parents, friends and school support across a segmented school day

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Published: 8 November 2007

Received: 5 June 2007

International Journal of Behavioral Nutrition and Physical Activity 2007, 4:54 doi:10.1186/1479-5868-4-54

Accepted: 8 November 2007

This article is available from: <http://www.ijbnpa.org/content/4/1/54>

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Abstract

Background: Whilst evidence exists for the influence of encouragement on physical activity participation, the diversity of support sources and the type of physical activity examined previously is limited. This study examined the importance of perceived encouragement from parents, siblings/cousins, friends, and schools on participation levels across three time-specific activity opportunities that are available during a school day (after-school physical activities, lunchtime activity, and active transportation to and from school).

Methods: A cross-sectional sample of 12–18 year old high school students ($n = 3,471$) were recruited from low SES schools within South Auckland, New Zealand and categorised as either Junior (Years 9–11) or Senior (Years 12 & 13) students. Participants reported their physical activity levels and quantity of encouragement received from their parent(s), friend(s), sibling(s)/cousin(s), and school to be active. For each physical activity variable participants were dichotomized as being either "active" or "less active". For each social support source, participants were grouped into either receiving "high" or "low" levels of support. Binary logistic regression analyzes were conducted to calculate odd ratios and 95% confidence intervals.

Results: Low parental support (Juniors, OR: 0.47, 95% CI: 0.38–0.58; Seniors, OR: 0.41, 95% CI: 0.29–0.60) and low peer support (Juniors, OR: 0.61, 95% CI: 0.51–0.74; Seniors, OR: 0.49, 95% CI: 0.35–0.69) were associated with reduced odds of being regularly active after school. For lunchtime activity, low peer support (Juniors, OR: 0.39, 95% CI: 0.32–0.48; Seniors, OR: 0.41, 95% CI: 0.29–0.57) was associated with reduced odds of being categorized as active. While no variables were significantly related to active transportation among senior students, low peer support was associated with reduced odds of actively commuting for Junior students (OR: 0.78, 95% CI: 0.66–0.92). Irrespective of the activity examined, no significant difference was noted for students receiving high support from two parents than students reporting high support from their sole parent in a single parent family.

Conclusion: The importance of encouragement from parents, siblings, friends, and schools on physical activity is dependant on the time-specific activity examined. It is clear that proximal social networks need to be considered during the development of physical activity promotion strategies.

Background

The high school years is a period of life consistently associated with a subsidence in physical activity levels [1-5]. To slow down or reverse this trend, gaining a greater insight into the determinants of youth physical activity is required. Determinant-based frameworks of physical activity have been developed which focus on broad, multi-level, ecological health promotion approaches that work toward understanding the modifiable social and physical environmental determinants of physical activity [6,7]. Despite the recent upsurge and popularity in studies examining how the physical environment influences physical activity habits, further research into the relative importance of social support from various sources continues to be advocated [8].

Encouragement, role modelling, and logistical support are all examples of social support that have been positively associated with youth physical activity participation [8-18]. Among these elements, however, encouragement may have a longer lasting effect on behaviour change as not only does encouragement act directly on physical activity, but indirectly through its influence on self-efficacy [10,19], a key psychosocial variable repeatedly found to be associated with physical activity among young people [10,11,20-25].

Physical activity research, however, has been focused predominantly on two sources of encouragement – parents and friends – with little consideration of encouragement provided by siblings, extended family members (e.g., cousins), and schools. In New Zealand, living with extended family members is common among certain ethnic groups (e.g., Pacific Islanders) and therefore needs consideration [26]. When parental support has been examined, family type (e.g., no parents, two parent families, and single parent family) has rarely been considered. In 2001, 29% of families with dependent children in New Zealand were single parent families, placing New Zealand only behind America as having the second highest percentage of sole parent families among OCED countries [27]. Considering single parent families are disadvantaged economically and socially when compared to two-parent families [27] examining the influence of family type on youth physical activity levels is warranted. Furthermore, adolescence is a period of life characteristic of increasing independence from families and expanding social networks external to the family environment [28].

While prior studies support the encouragement – physical activity link, the studies have lacked diversity in the range of physical activities examined. Participation in vigorous or moderate-to-vigorous intensity physical activity has typically been examined with little attention directed towards activities undertaken at specific time periods or

segments of a school day (e.g., after-school activity, lunch-time activity, before school through active transportation) in which young people can be active. Ecological models, which are holistic and consider both intraindividual and environmental correlates of the targeted behaviour (e.g., physical activity), posit that influencers most proximal to the target group will have the strongest effect on the desired behaviour [7]. Hence, the importance of support from parents, friends, siblings, and schools is likely to be dependent on the location, period of the day, and context of physical activity examined. Initiating this type of investigation, authors of a recent study of Norwegian youth aged 9 or 15 years old concluded that psychosocial correlates of physical activity appear to be location specific, but further examination is warranted to provide further insight. [29].

To overcome the identified gaps in literature, the aim of the current study was to simultaneously examine the importance of perceived encouragement from parents, siblings/cousins, friends, and schools on participation in after-school physical activities, lunchtime physical activity, and engagement in active transportation to and from school.

Methods

Data Collection

The OPIC (Obesity Prevention In Communities) project is an obesity prevention initiative focusing on high school aged students which is being conducted across four countries (Australia, New Zealand, Fiji, and Tonga). Within each country the project is being carried out within a predetermined suburb/neighborhood. The measures and data of this study represent a portion of the variables and data collected from schools participating in the New Zealand aspect of the OPIC project.

Sample

Students were recruited from seven low SES (decile rating of 1 or 2) high schools located in South Auckland, New Zealand. The decile rating, which ranges from 1 (most deprived) to 10 (least deprived), indicates the extent to which the school draws its students from low socioeconomic communities. The response rate varied by school, from 25% up to 78% (school average = 58%). For all schools combined, the original sample surveyed in 2005 was 3,581 (response rate of 53% from 6,827 students) and from these 14 participants (0.4%) were excluded due to not meeting age criteria for inclusion (i.e., 12–18 years old, inclusively) with a further 96 participants (2.7%) excluded as a result of incomplete data. The final sample consisted of 3,471 participants (97% of the original sample) with a mean age of 14.8 ± 1.4 years, and a composition of 48% male, 72% junior students (Years 9–11) and a mix of different ethnicities (Pacific Island descent, 57%;

Māori, 20%; European, 12%; Asian/Other, 11%). Written consent was gained from all students. For students aged below 16 years written parental consent was obtained for most students with a small number of parents providing consent orally over the phone. Consent was also gained from the principal of each school.

Measures

Physical activity, perceived encouragement, and demographic variables were collected using an electronic (i.e., personal digital assistant, PDA) self-report questionnaire administered during a scheduled class time. A pilot study of the survey was conducted with four classes, one class at each year level (Year 9 through to Year 12), to examine comprehension level and survey completion time.

Demographic variables

The questionnaire requested information on age, gender, and ethnicity. For ethnicity, participants selected the main ethnic group they identified with from a list of New Zealand relevant ethnic groups. For the purpose of analyses, students in Years 9, 10, and 11 were grouped as junior high school students, while senior high school students refers to those participants in Years 12 and 13.

Physical activity variables

The questionnaire contained three separate items to assess physical activity in the form of active transportation, activity during lunchtime and activity during the after-school time period. These items were directly replicated from the New Zealand Child Nutrition Survey (CNS) [30], a national survey of physical activity and nutrition among children. The New Zealand CNS survey was based on the Physical Activity Questionnaire for Children (PAQ-C), a questionnaire that has demonstrated acceptable reliability and validity [31-33]. Of the items that comprise the New Zealand CNS, questions that individually examined after-school activity and lunchtime activity were used in this study. Face/content validity of each question was assessed by the authors, and participant comprehension was tested during the piloting of the entire OPIC survey.

For after-school physical activity participants were asked to self-report the number of days (0-5 days) over the previous 5 school days they participated after school in sports, dance, cultural performances, or played games in which they were active. Based on their self-reported level of participation, participants were dichotomized into 'active' (i.e., participated in after-school activities on at least 3 school days) or 'less active' (i.e., participated in after-school physical activities on 2 or fewer days) groups.

In terms of lunchtime physical activity, participants were asked 'over the last 5 school days, what did you do most of the time at lunchtime (apart from eating)*'. Participants

chose one of the following three response options: 'mostly just sat down', 'mostly stood or walked around', or 'mostly played active games'. Based on their self-reported level of participation, participants were dichotomized into 'active' (i.e., mostly played active games) or 'less active' (i.e., mostly just sat down or mostly stood or walked around) groups.

For active transportation, each participant reported the number of trips he/she made by biking or walking to or from school over the previous 5 school days. Based on their self reported level of participation, participants were dichotomized into 'active' (i.e., walked/biked to or from school for at least 5 trips in the previous school week) or 'less active' (i.e., walked/biked to or from school for fewer than 5 trips in the previous school week) groups.

Perceived encouragement

Similar to items used in previous studies [10,34], perceived encouragement from the participant's mother, father, brothers/male cousins, sisters/female cousins, friends, and school was assessed individually using the following question format: 'How much does your [support source] encourage you to be physically active or play sports'. Participants responded using a 5-point response scale (a lot, some, a little, not at all, don't have/live with my [support source]).

Due to the potential of collinearity to occur between certain support sources, responses for maternal and paternal support were combined into a single independent variable referred to as 'parental encouragement' whilst responses for brother/male cousin and sister/female cousins were combined to form the independent variable of 'sibling/cousin encouragement'.

Based on their survey responses, participants were grouped into 'high' (i.e., reported receiving a lot of encouragement) and 'low' (i.e., reported receiving some to no encouragement) encouragement groups for each support source. The groups were then further divided according to their family structure (e.g., single parent family, two parent family, no parents) which was constructed from the participant's responses to maternal and paternal encouragement questions.

For parental encouragement, participants were classified as either receiving (1) high support from both parents in a two parent family, (2) high support from at least one parent from a two parent family, (3) high support from one parent within a single parent family, (4) low support from both parents within a two parent family, and (5) low support from their sole parent within a single parent family or does not live with his/her parents. In terms of sibling/cousin encouragement, participants were classified

into one of three groups; high support from brothers/male cousins or sisters/female cousins, low (but not high) support from either brothers/male cousins or sisters/female cousins, and does not have siblings/cousins. For friend and school support, participants were grouped as either receiving high support or low support for each support source.

Data analysis

Data were analyzed using Statistical Analysis System (SAS) version 9.1 (SAS Institute Inc., Cary, NC, USA), with corrections for any design effects arising from sampling students by class. Using binary logistic regression both univariate and multivariate analyses were conducted to calculate odd ratios (crude and adjusted, respectively) and 95% confidence intervals. Both univariate and multivariate models were adjusted by sex and ethnicity.

Developing the multivariate model consisted of a two step process. First, the 'proc logit' procedure in SAS was conducted to identify significant predictor variables based on mutual adjustment of all predictor variables while adjusting for sex and ethnicity also. All predictor variables with a p-value below 0.05 were identified and kept for the

final multivariate model. As the variables had not been corrected for cluster sampling during this process, the final model was then tested through the 'Proc surveylog' procedure to calculate adjusted odds ratios (OR's) and 95% confidence intervals (95% CI) that were adjusted by sex and ethnicity and corrected for cluster sampling.

Results

After-school physical activity

Univariate analyses (Table 1) showed that encouragement from all sources (with the exception of school support for senior students) were significantly associated with frequency of after-school physical activities. After conducting the stepwise process, encouragement from parents (junior students, $p < 0.0001$; senior students, $p < 0.0001$) and friends (junior students, $p < 0.0001$; senior students, $p = 0.0001$) remained significant across all groups while sibling/cousin support was only significant for junior students ($p = 0.0001$). As shown in Table 1, these variables remained significant for their respective age groups in the multivariate model once cluster sampling was corrected for.

Table 1: Univariate and multivariate analysis of perceived support from various sources for participation in after-school physical activity.

	Juniors (n = 2,490)				Seniors (n = 981)			
	Total n	% active ^a	Univariate model OR (95% CI) [‡]	Multivariate model [†] OR (95% CI) [‡]	Total n	% active ^a	Univariate model OR (95% CI) [‡]	Multivariate model [†] OR (95% CI) [‡]
Parent(s)								
High (2/2 parents)	99	70.0	1.0 [§]	1.0 [§]	54	72.2	1.0 [§]	1.0 [§]
High (1/1 parent)	1007	62.6	0.78 (0.47-1.29)	0.87 (0.53-1.44)	281	59.3	0.56 (0.30-1.06)	0.62 (0.33-1.16)
High (1/2 parents)	456	55.5	0.54 (0.43-0.68)	0.64 (0.50-0.80)	166	59.6	0.58 (0.39-0.86)	0.68 (0.45-1.01)
Low (2/2 parents)	753	44.1	0.36 (0.29-0.44)	0.47 (0.38-0.58)	390	42.1	0.33 (0.23-0.48)	0.41 (0.29-0.60)
Low (1/1, no parents)	175	41.1	0.33 (0.24-0.47)	0.46 (0.32-0.65)	90	36.7	0.25 (0.15-0.44)	0.31 (0.18-0.55)
Sibling/Cousin(s)								
High	1241	67.9	1.0 [§]	1.0 [§]	392	65.1	1.0	
Low	1095	46.5	0.45 (0.39-0.53)	0.66 (0.56-0.79)	515	47.0	0.54 (0.41-0.73)	
No sibling	154	46.8	0.51 (0.36-0.71)	0.71 (0.50-1.02)	74	45.9	0.65 (0.39-1.10)	
Friend(s)								
High	986	70.1	1.0 [§]	1.0 [§]	385	70.4	1.0 [§]	1.0 [§]
Low	1504	48.7	0.45 (0.38-0.54)	0.61 (0.51-0.74)	596	43.6	0.40 (0.29-0.54)	0.49 (0.35-0.69)
School								
High	1369	62.3	1.0 [§]		546	57.2	1.0 ^{ns}	
Low	1121	50.9	0.67 (0.57-0.79)		435	51.6	0.85 (0.67-1.08)	

^aparticipated in sport, dance, cultural performances, or played active games after school on at least 3 weekdays

[†] only variable found significant ($p < .05$) through the stepwise process were included in the final multivariate model

[‡] Corrected for cluster effect and controlled for sex and ethnicity

[§] $p < .0001$; ^{||} $p = .0003$; ns = non-significant

Based on the multivariate models (Table 1) youth who received low parental support were less likely to be considered active after school compared to youth who received high levels of encouragement from both parents. Also, youth who resided in a single parent family but received high support from their sole parent were just as active after school as youth who received high support from two parents. Among junior students with siblings, those who received low support were less likely to be regularly active after-school. Furthermore, low friend support increased the likelihood of not being active after school with reported adjusted OR's of 0.61 (95% CI: 0.51-0.74) and 0.49 (95% CI: 0.35-0.69) for junior and senior students, respectively.

Lunchtime physical activity

Based on univariate analyzes (Table 2), all sources of support (parents, friends, siblings/cousins, and school) were significantly associated with being active at lunchtime for both junior and senior students. After conducting the stepwise process, only perceived friend support was significantly related to lunchtime physical activity levels for both junior (p < 0.0001) and senior (p < 0.0001) students. Parental support (p = 0.01) and school support (p

= 0.03) also remained significant for junior students only. As shown in Table 2, these variables, with the exception of school support, remained significant for their respective age groups in the multivariate model once cluster sampling was corrected for. For both junior (OR: 0.39, 95% CI: 0.32-0.48) and senior students (OR: 0.41, 95% CI: 0.29-0.57), the multivariate models show that students reporting low peer support are less likely to be categorized as active (i.e., mostly played active games) compared to those reporting high levels of encouragement from friends. Also, among junior students from two-parent families, those receiving low support from at least one parent are less likely to be active during lunchtime with noted OR's of 0.68 (95% CI: 0.54 - 0.87) for students with low parental support from two-parent families and 0.77 (95% CI 0.59 - 0.99) for students with high support from only one parent from a dual parent family.

Active transportation

As shown in Table 3, univariate analyzes identified that only peer support among junior students was significantly associated with frequency of active transportation (i.e., walking/biking at least five times to or from school over a school week). After adjusting for all predictor variables

Table 2: Univariate and multivariate analysis of perceived support from various sources for participation in lunchtime physical activity.

	Juniors (n = 2,490)				Seniors (n = 981)			
	Total n	% active*	Univariate model OR (95% CI)†	Multivariate model† OR (95% CI)‡	Total n	% active*	Univariate model OR (95% CI)‡	Multivariate model† OR (95% CI)‡
Parent(s)								
High (2/2 parents)	99	43.8	1.0 [§]	1.0 ^{**}	54	36.3	1.0 [§]	
High (1/1 parent)	1007	33.3	0.82 (0.50-1.34)	0.92 (0.55-1.54)	281	31.5	0.92 (0.50-1.68)	
High (1/2 parents)	456	33.1	0.64 (0.50-0.82)	0.77 (0.59-0.99)	166	26.5	0.66 (0.44-0.99)	
Low (2/2 parents)	753	26.8	0.51 (0.40-0.65)	0.68 (0.54-0.87)	390	19.7	0.53 (0.37-0.76)	
Low (1/1, no parents)	175	24.6	0.49 (0.33-0.73)	0.70 (0.46-1.04)	90	17.8	0.49 (0.26-0.93)	
Sibling/Cousin(s)								
High	1241	43.3	1.0 [§]		392	34.4	1.0 [§]	
Low	1095	26.7	0.52 (0.43-0.63)		515	21.2	0.60 (0.45-0.79)	
No sibling	154	26.6	0.59 (0.39-0.90)		74	16.2	0.50 (0.21-1.19)	
Friend(s)								
High	986	51.8	1.0 [§]	1.0 [§]	385	39.7	1.0 [§]	1.0 [§]
Low	1504	23.9	0.34 (0.28-0.42)	0.39 (0.32-0.48)	596	17.3	0.41 (0.29-0.57)	0.41 (0.29-0.57)
School								
High	1369	39.2	1.0 [§]		546	30.3	1.0 [§]	
Low	1121	29.7	0.64 (0.52-0.79)		435	22.7	0.71 (0.51-0.98)	

* played active games most of the time

† only variables found significant (p < .05) through the stepwise process were included in the final multivariate model

‡ Corrected for cluster effect and controlled for sex and ethnicity

§ p = <.0001; || p=.001; ¶ p = .007; ** p = .02; †† p = .04; ns = non-significant

through the stepwise process, friend support ($p = 0.005$) and school support ($p = 0.04$) were significant for junior students. No significant variables emerged for senior students, therefore, no multivariate model was tested for this age group. For junior students, the multivariate model, once corrected for cluster sampling, shows that junior students who receive low peer support have a reduced odds (OR: 0.78, 95% CI: 0.66 – 0.92) of undertaking at least 5 trips to or from school by active transportation modes, while low school support was associated with an increased odds of commuting actively on a regular basis (OR: 1.20, 95% CI: 1.02 – 1.40).

Discussion

This study examined the importance of one form of social support (i.e., encouragement to do physical activity) from four support sources (parents, siblings/cousins, friends, and schools) across three time-specific physical activities (after-school physical activity, lunchtime physical activity, and active transportation to and from school). A key and novel finding of this study was that the importance of encouragement from the various sources was dependent on the time-specific activity examined.

After-school physical activity

In line with prior research [8], we identified that encouragement from parents and friends was a key contributor to youth being active after school irrespective of age cluster. During adolescence, therefore, both parents and friends play an important role in the socialization of teenagers to after school activities. Students who reported receiving high support from at least one parent were just as likely to be active on most days during the after-school period, compared to their peers who received high levels of support from two parents. These findings provide a positive picture that youth from single parent families can be just as active after school as students from two parent families, as long as the available parent provides a high level of encouragement towards his/her offspring. Frequency of after-school activities was also significantly associated with peer encouragement, with students receiving limited support being less likely to be regularly active after school compared to their counterparts receiving higher levels of peer support. In addition, a significant association with sibling/cousin support emerged for junior but not senior students. In particular, among junior students with siblings/cousins, those who received high support were more likely to be active after school. The finding that the importance of sibling/cousin encouragement differed by age

Table 3: Univariate and multivariate analysis of perceived support from various sources for participation in active transportation to and from school.

	Juniors (n = 2,490)			Seniors (n = 981)			
	Total n	% active ^a	Univariate model OR (95% CI) [‡]	Multivariate model [†] OR (95% CI) [‡]	Total n	% active ^a	Univariate model OR (95% CI) [‡]
Parent(s)							
High (2/2 parents)	99	61.6	1.0 ^{ns}		54	55.5	1.0 ^{ns}
High (1/1 parent)	1007	59.6	0.90 (0.62–1.32)		281	59.3	1.22 (0.67–2.24)
High (1/2 parents)	456	60.7	0.97 (0.79–1.20)		166	53.6	0.96 (0.68–1.37)
Low (2/2 parents)	753	57.0	0.85 (0.71–1.03)		390	49.7	0.93 (0.68–1.28)
Low (1/1, no parents)	175	61.7	1.01 (0.74–1.39)		90	58.9	1.32 (0.77–2.26)
Sibling/Cousin(s)							
High	1241	61.3	1.0 ^{ns}		392	57.1	1.0 ^{ns}
Low	1095	58.8	0.91 (0.78–1.07)		515	52.2	0.89 (0.64–1.24)
No sibling	154	57.1	0.87 (0.62–1.22)		74	41.9	0.62 (0.40–0.96)
Friend(s)							
High	986	63.4	1.0 [†]	1.0 [†]	385	55.8	1.0 ^{ns}
Low	1504	57.7	0.81 (0.69–0.95)	0.78 (0.66–0.92)	596	51.8	1.02 (0.77–1.36)
School							
High	1369	58.4	1.0 ^{ns}	1.0 ^{††}	546	51.3	1.0 ^{ns}
Low	1121	61.9	1.14 (0.98–1.33)	1.20 (1.02–1.40)	435	55.1	1.21 (0.91–1.61)

^a walked/biked to or from school for at least 5 trips over the last 5 school days

[†] only variables found significant ($p < .05$) through the stepwise process were included in the final multivariate model

[‡] Corrected for cluster effect and controlled for sex and ethnicity

[§] $p = .004$; ^{||} $p = .01$; ^{††} $p = .03$; ns = non-significant

lends support to the perspective that during adolescence peers become powerful influencers, more so than family members; a finding similar to those noted in prior research [8,14,16]. This is not unexpected, and is likely a natural consequence of young people increasing their independence from families and expanding social networks external to the family environment as they move through adolescence [28]. Examining the sex, age, number of siblings/cousins and types of activities engaged in after-school may, however, help provide further insight into why this association emerged for junior students only.

Lunchtime physical activity

In contrast to the findings for after-school activities, friends emerged as the only consistent source of support associated with lunchtime physical activity levels across both age clusters. This is not unexpected as ecological models postulate that influencers most proximal to the target group will have the strongest effect on the desired behavior. During lunchtime and within a school setting the most proximal social force would be a friend, which explains why students who reported receiving low support from their peers were more likely to sit, stand, or walk around during lunchtime rather than play active games. A significant association with parental support emerged for junior students only, with low parental support from two parent families reducing the odds of their offspring to be considered active during lunchtime. For junior students, therefore, as long as they receive high support from either friends or parents, the probability of engaging in active play during lunchtime increases. The lack of an effect of parental encouragement on senior students is potentially indicative of the higher importance of peer influences with increasing age.

Active transportation

Perceived encouragement to be active was not associated with the regularity of walking or biking to and from school among senior students. For junior students, commuting actively to school was positively associated with friend support but inversely related to school support. The limited findings between perceived encouragement and active transportation is not unexpected as physical environment factors, which have been linked to both active transportation [35] and physical activity in general [36-39], are more likely to impede students undertaking active transport than perceived encouragement. For instance, no matter how much encouragement parents provide to their children to be active, if the family lives too far from school commuting actively is less likely to occur. Considering active transportation occurs outside the home and school environments, examination of social factors at the neighbourhood level (e.g., safety, people visible in the neighbourhood, level of neighbour interactions and cohesion)

may provide further insight into social influencers on active transportation patterns to and from school.

A particular strength of this study was the large and ethnically inclusive sample. In addition, this study is one of the first to examine the influence of perceived encouragement from various support sources across three time dependent physical activity opportunities that exist within a school day. Also, examining how many parents each participant lived with during a school week allowed the effect of different parental structures (single parent, dual parents, or no parents) to be investigated. The limitations of this study, however, need to be noted. As it was not the purpose of the larger Obesity Prevention in Communities (OPIC) project to obtain a nationally representative sample of youth but rather to over sample for Pacific Island youth with low socioeconomic status, the resulting sample is not representative of the New Zealand youth population. Although the sample composition is similar to that of the New Zealand high school population for gender (approximately 50% females), the sample differed substantially by ethnicity when compared to national statistics. The ethnic composition of the sample was 57% Pacific Island, 20% Māori, 12% European, and 11% Asian and Other compared to 7.6%, 24.5%, 62.4% and 5.0%, respectively, for the New Zealand child population (<15 years old). The generalizability of the findings to the New Zealand youth population must, therefore, be interpreted with some caution. Another limitation is the use of self-report measures [40], an unavoidable limitation as information about participation in specific physical activity contexts (e.g., active transportation) can only be confirmed by this method. Although accelerometers allow examination of physical activity intensity during certain time periods throughout a day, it cannot always distinguish the specific context in which the activity is taking place (e.g., physical activity after school could be due to sports participation or transport related physical activity). Reducing the self-report monitoring period to the week prior to the questionnaire completion day along with recalling frequency of activity during specific time periods, potentially reduce the effect of known associative recall bias of self-reports [40] when compared to longer monitoring frames or when specific duration of physical activities are examined. Although the encouragement questions were based on questions included in prior studies (thereby allowing cross study comparisons), the use of a single question may not accurately capture the complexity of perceived encouragement. Furthermore, school encouragement may have been interpreted differently among participants, in terms of source (e.g., support from head teacher, senior managers/teachers, physical education teachers) and type of encouragement (e.g., supportive school ethos, instrumental support, verbal encouragement). Clarifying the definition of school sup-

port is required in future studies. Other limitations include the use of cross-sectional data, which limits the ability to examine the impact of perceived support on the development of physical activity levels during the high school years longitudinally. Also, only one type of perceived support was examined which prevented the impact of overall support on youth activity to be analyzed.

Conclusion

The findings from this study highlight the importance of proximal social networks on youth activity which should be considered when developing policies and programs looking to promote physical activity among young people. The findings also provide further evidence that parents and friends are the key social influencers of physical activity during adolescence. To determine the true effect of school support on adolescent physical activity, further research is required that utilizes more in-depth and specific question(s) to assess school encouragement and the wider school environment that may impact on perceived encouragement (e.g., the school ethos).

Competing interests

The author(s) declare that they have no competing interests.

Authors' contributions

RS is the principal investigator and DS a co-investigator on the Obesity Prevention in Communities (OPIC) project from which these data were obtained. MH, RS, GS and DS were all involved in survey design and acquisition of data. GS provided guidance regarding the statistical analyzes to be applied. GS and GK assisted with the interpretation of the results. MH developed the first draft of the manuscript while all other authors contributed to the writing of the manuscript.

Acknowledgements

The authors would like to thank the principals and students of the schools that participated in the OPIC project. Also, the Health Research Council (HRC) of New Zealand provided funding for the OPIC project through the School of Population Health, University of Auckland, and a PhD scholarship for the primary author.

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Pedometer-Determined Physical Activity Levels of Adolescents: Differences by Age, Sex, Time of Week, and Transportation Mode to School

Maea Hohepa, Grant Schofield, Gregory S. Kolt, Robert Scragg, and Nick Garrett

Background: Few studies have examined high school students' physical activity habits using objective measures. The purpose of this study was to describe pedometer-determined habitual physical activity levels of youth. **Methods:** 236 high school students (age 12–18 years) wore sealed pedometers for 5 consecutive days. Data were analyzed using generalizing estimating equations. **Results:** Mean steps/d (\pm SE) differed significantly by sex (males, $10,849 \pm 381$; females, 9652 ± 289), age (junior students [years 9–11], $11,079 \pm 330$; senior students [years 12 and 13], 9422 ± 334), time of week (weekday, $12,259 \pm 287$; weekend day, 8241 ± 329), and mode of transportation to and from school (walkers, $13,308 \pm 483$; car transit users, $10,986 \pm 435$). Only 14.5% of students achieved at least 10,000 steps on every day during the monitoring period. **Conclusion:** Daily step counts differed substantially by age, sex, time of week, and transportation mode to school.

Keywords: step counts, descriptive, adolescent, commuting

Increasing physical activity among youth is a priority in many countries, including New Zealand.¹ Around the globe, knowledge about youth physical activity behaviors is based predominantly on survey-derived data, a measurement method associated with well-described limitations.^{2–4} In comparison, few studies^{5–8} have examined the physical activity habits of high school students using objective measures.

One objective measure becoming more popular in physical activity research is pedometry. Pedometers are small digital devices typically worn on the waist that measure step counts as a result of vertical body displacement (eg, hip acceleration). Pedometers provide an unobtrusive and inexpensive method for objectively assessing total physical activity in research and health-promotion settings. Depending on

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brand, pedometers have high accuracy in counting steps and provide a valid option for assessing physical activity among children and adults.⁹⁻¹¹

Since the conception of the pedometer, cut points for assessing pedometer-determined physical activity have emerged. The well-known criterion of 10,000 steps per day is frequently used in public health-promotion initiatives and by private health-promotion organizations. For ostensibly healthy adults, 10,000 steps per day indicates an active lifestyle,¹² which roughly equates to the 30-minutes-per-day physical activity message.^{13,14} Only recently have preliminary guidelines specific to the child population emerged. Body mass index-referenced standards for children age 6 to 12 years suggest 15,000 steps per day for boys and 12,000 steps per day for girls.¹⁵ Based on a descriptive study of 711 children (age 6–12 years), Vincent and Pangrazi¹⁶ recommended 11,000 steps per day for girls and 13,000 steps per day for boys. Although youth age 6 to 17 years are recommended to accumulate at least 11,000 steps on at least 5 days per week as part of the Presidential Active Lifestyle Award,¹⁷ this criterion is largely arbitrary. A health-based threshold for assessing step values specific to the adolescent population has yet to be established.

Average daily step-count values by sex and age are commonly reported in youth studies. Pedometer evidence has consistently shown that males are more active than females, with aggregated daily step count values ranging between 10,000 and 13,700 for males and 8400 and 11,300 for females.^{5-8,18,19} In addition, a trend toward reduced activity with age is typically observed,^{5,8,20} with steps counts peaking at age 12.8 years for females and 14.3 years for males.⁸

Researchers, however, have yet to examine the number of young people meeting any step-based criteria. An obvious limitation of conducting such an examination is the absence of a criterion-based step threshold specific to the age range represented during the high school years. The 10,000-step threshold, which is reflective of being considered active during adulthood,¹² however, provides a conservative criterion for the youth population considering the commonly reported decline in physical activity during adolescence. For this reason, the proportion of students achieving at least 10,000 steps per day is examined in the current study.

In addition to determining overall activity, identifying key periods of low physical activity is crucial in directing future health-promotion efforts. A convenient way to delineate these periods for youth is by dividing the week into school days (weekdays) and weekend days. Based on the limited evidence, some studies of high school students show significantly higher activity counts^{21,22} and step counts²³ on weekdays, whereas other studies show lower step counts (significance not stated) on weekdays⁸ or no significant differences between time periods when physical activity is assessed by heart-rate monitoring.²⁴ The equivocal research findings in this area indicate that further investigation is warranted.

Irrespective of time of week, youth can accumulate health-related physical activity within a number of contexts. One physical activity context receiving increased research attention is transport-related physical activity. Although increasing the prevalence of active transportation among young people is recommended,²⁵ especially walking to and from school, the importance of active transportation to daily physical activity levels of high school students has rarely been examined. A recent study found that students (13–14 years) who walked to and from school achieved 25.9 more minutes of moderate-to-vigorous physical activity (as assessed by accelerometry) than did their peers who traveled by car, bus, or train to and from school.²⁶

Although several studies have examined youth physical activity with objective measures (eg, using pedometry), several limitations with the methodology employed are apparent. First, previous research has included only those participants who had complete step data for a predefined number of days (typically a minimum of 4 days). Although this process is not a limitation for studies on children that typically report low exclusion levels, it might potentially bias the sample, and subsequently, the results of studies noting high exclusion levels (>30% exclusion level), which is apparent in studies of adolescents.⁶ Second, although longitudinal data are usually collected, step-count data are frequently averaged before analysis, which substantially reduces the number of observations per participant to 1 and reduces the potential statistical power. Third, some previous statistical analyses have been applied to daily step-count averages in which the number of monitoring days might differ between participants (eg, some participants have complete step data for 4 days, whereas other participants have complete data for 5 days or 6 days). The common statistical analyses applied to these averages will not account for within-subject variation or differences in variance of step counts when the number of monitoring days varies between participants. To address the just-mentioned limitations, the data in our study have been analyzed using generalizing estimating equations (GEE).

The aims of the current study, therefore, were twofold. First, our aim was to examine daily step counts and make comparisons by age, sex, time of week, and transportation mode. Second, we aimed to determine the percentage of youth who meet the 10,000-steps-per-day criterion by sex and age.

Methods

This study is linked with a larger study known as the Obesity Prevention in Communities (OPIC) project, an ecological-based obesity prevention initiative focusing on high school students that is being conducted across 4 countries (Australia, New Zealand, Fiji, and Tonga). In New Zealand, the intervention is targeting youth attending schools with a low socioeconomic rating within a predefined suburb in South Auckland, New Zealand. Based on reducing school burden, 3 of the intervention schools were approached to participate in this pedometer study.

Sample

Data were collected from a convenience sample of students attending 1 of 3 high schools within Manukau City, Auckland. All schools were of low socioeconomic status with a decile rating of 1 or 2. The decile rating is a proxy for socioeconomic status ranging from 1 (most deprived) to 10 (least deprived). From the 3 schools, 20 classes in total were approached to participate in this study, with the number of classes approached per school relative to the number of students attending each school. A total of 348 students agreed to participate.

Only participants age 12 to 18 years were included for analysis. Through using GEE analysis, which is a standard statistical method often used in situations in which there is missing longitudinal data,²⁷ all participants who had a least 1 weekday of pedometer data were considered for inclusion in the analysis. The inclusion of data with only 1 or 2 data points overcomes the potential sample bias that could

occur if such data were excluded. All step values collected on days with reported compliance (ie, not detaching the pedometer for more than 1 waking hour per day) were included. Dealing with outliers among the youth population has received little attention. In line with a recent study on children,²³ daily step counts between 1000 and 30,000 were included.

For GEE analysis, participants were excluded if they (1) were outside the age criteria ($n = 4$, 1.1%), (2) had provided no age data ($n = 9$, 2.6%), (3) had no weekday data ($n = 4$, 1.1%), (4) had no pedometer data ($n = 51$, 14.7%), (5) did not comply with pedometer instructions ($n = 37$, 10.6%), or (6) had all their pedometer data points below 1000 steps or greater than 30,000 steps ($n = 7$, 2.0%). In total, 112 participants (32.2%) were excluded, leaving a final sample of 236 participants with 844 usable data points. The exclusion of 32% of the participants is similar to another pedometer-based study of high school students that used more stringent inclusion criteria and reported an exclusion percentage of 39%.⁶ Chi square analysis revealed no significant sex or age-group differences between the included and excluded participants.

Of the 236 participants (mean age = 15.3 ± 1.6 years), female (59.7%) and junior (year 9, 10, and 11 students, 58.5%) students composed a larger proportion of the sample than did their male and senior (year 12 and 13 students) peers, respectively. Ethical approval was gained from the Auckland University of Technology Ethics Committee. Informed consent to participate was obtained from the principals of each school, all participants, and parents for students below 16 years of age.

Measures

Pedometer. The NL-2000 pedometer (New-Lifestyles Inc) was used because it displays high accuracy (within $\pm 3\%$ of actual step taken) and intramodel reliability^{28,29} and has the memory capacity to store 7 consecutive days of data. A check of functionality and reliability of each pedometer was conducted before the start of the study with a step-count test. All pedometers were found to be within the acceptable $\pm 3\%$ margin of error. Before the reuse of each pedometer, the pedometer's clock was checked to ensure the 1-day epoch covered the 24-hour time period from midnight to midnight.

Questionnaire. Mode of transport to and from school was collected by questionnaire. Participants were asked to indicate how they traveled to and from school on each of the previous 3 school days by choosing 1 of 4 response options (car, bus, walk, and bike). For analysis purposes, students were categorized into 1 of 5 groups: car only (traveled to and from school by car), bus one way (traveled by bus to or from school but did not walk), bus only (traveled to and from school by bus), walk one way (traveled to or from school by walking), and walk only (traveled to and from school by walking).

Data Collection

Data were collected during the Southern hemisphere spring season (between late August and early November) in 2005. Before data collection, all students were informed about the study and the required consent forms, and information sheets were distributed to each participant and collected once completed. On the first

monitoring day, participants received a sealed pedometer and instructions regarding pedometer attachment. Participants were asked to wear the pedometer from the time they woke up in the morning until bedtime the same day, every day for 7 days. Only during water-based activities (eg, swimming, showering) and competition contact sport were the participants instructed to detach and reattach their pedometer directly before and after the activity, respectively. On the final monitoring day, participants returned their pedometers and completed a short questionnaire (to gain information on their main mode of transportation to and from school) and a compliance form (requesting information on how many hours they did not wear the pedometer on each of the previous 5 days). Noncompliance with the pedometer instructions was operationalized as individuals detaching the pedometer for more than 1 hour during their wake time, a protocol used in previous studies.⁶ Data collected on monitoring days 2 through 6 were included in the analyses because pedometer distribution and collection took place on monitoring days 1 and 7; these days, therefore, did not represent complete data. As a result, 5 full days of complete pedometer data could be potentially collected per participant.

Data Analysis

The data were analyzed using the GEE procedure with repeated measures and an unstructured correlation matrix. GEE was chosen because (1) the variation in step counts for each potential collection period (1–5 days) is taken into account, thereby allowing inclusion of participants who wore the pedometer for a minimum of 1 day and, in turn, maximizing participant retention and sample size; (2) it maximizes statistical power of the study design by analyzing all data points rather than averaged step counts; and (3) it takes into consideration the covariance structure of the repeated data points, which are likely to be correlated.

Data were analyzed using Statistical Analysis System (SAS) version 9.1 (SAS Institute Inc, Cary, NC, USA), with corrections for any design effects arising from the sampling method employed. Through the GENMOD procedure in SAS, GEE estimated daily step counts and standard errors according to age group, sex, time of week, and engagement levels in active transportation with respective *P* values. For each GEE model, all potential main effects (age, sex, time of week), as well as all possible 2-way and 3-way interactions were initially entered into the model and examined for significance. Using a stepwise process, only those interactions and main effects that were significant ($P < .05$) were included in the final GEE model.

When determining the proportion of days students were reaching 10,000 steps, only those students with at least 3 days of pedometer data were included for the analysis ($n = 193$). The following method was used to determine the percentage of days each student achieved the 10,000-step criterion: (the number of days meeting the recommended guidelines/total number of usable days monitored) $\times 100$. Each participant was then categorized into 1 of 4 groups: never (did not achieve 10,000 steps on any day for which they have complete data), sometimes (achieved 10,000 steps at least once but on less than half of the days for which they had complete data), often (achieved 10,000 steps on at least half, but not all, of the days for which they had complete data), and always (achieved 10,000 steps on all days for which they had complete data).

The reasons for choosing the 10,000-step threshold are as follows. First, in a population in which physical activity substantially declines during the high school years, the 10,000-steps-per-day threshold, which is reflective of being active for adults, can be considered a conservative level that most young people should try to achieve. Second, 10,000 steps per day provides a middle ground between step thresholds that consider adults to be somewhat active (7500–9999 steps per day)¹² and preliminary thresholds for children (12,000–15,000 steps per day).¹⁵ Third, although determining the proportion of students achieving this criterion does not represent the percentage considered active, nor does it correspond to a magic number in which health benefits appear for any population group, it does provide a benchmark to monitor physical activity trends of high school students. Future research, however, needs to establish best practice step cut points for the adolescent population that are based on a health criterion and that are in line with recent time-based guidelines.³⁰

Results

Daily Step Counts

Table 1 shows the results from the GEE analyses used to estimate daily step counts while adjusting for clustering by school. Daily step counts differed by sex, age group, and time of week. Table 1 shows, after adjusting for all factors, that males accumulated nearly 1100 more daily steps than their female peers, junior students accrued over 1600 more steps daily than their senior peers, and higher daily step counts were achieved on weekdays than on weekend days. In addition, a significant age-group by time-of-week interaction emerged. A larger

Table 1 Estimated Daily Step Counts (\pm Standard Error) According to Sex, Age Group, and Time of Week, Adjusted for Each Other (n = 236)

Variable and grouping	Estimated daily steps \pm SE ^a	P value
Sex		.01
female	9652 \pm 289	
male	10,849 \pm 381	
Age group		.0004
junior	11,079 \pm 330	
senior	9422 \pm 334	
Time of week		<.0001
weekday	12,259 \pm 287	
weekend	8241 \pm 329	
Time of week by age group		.01
weekday junior	13,575 \pm 401	
weekend junior	8583 \pm 420	
weekday senior	10,944 \pm 374	
weekend senior	7900 \pm 470	

^a SE corrected for cluster effect by school.

reduction in step counts from weekdays to weekend days was observed for the junior school students than for their senior counterparts. Although there was a significant step-count deferential between age groups on weekdays, this was not the case for weekend activity.

Engagement in Active Transportation

From the sample of 236 participants, 230 had completed questions on transportation to and from school and were, therefore, included for analysis. Daily step counts were limited to the school days only. Results from the GEE procedure examining daily step counts by level of engagement in active transportation to and from school on weekdays are shown in Table 2. After adjusting for age, sex, and the school effect, the final GEE model revealed significant differences in accrued steps between those using different transportation modes ($P = .006$). Compared with the car only reference group, the walk only group accumulated over 2300 more steps, and the walk one way group accrued over 1700 extra steps daily.

The proportion of students using the different modes of transportation by school is presented in Table 3. Substantial differences in transportation patterns between the 3 participating schools are apparent. Most students in school 2 (56.7%) walked to and from school, whereas a smaller proportion of students undertook this behavior at school 1 (38.9%). Only 7% of students at school 3 traveled to and from school by car.

Table 2 Estimated Weekday Daily Step Counts (\pm Standard Error) According to Mode of Transportation Adjusted by Age and Sex (n = 230)

Mode of travel	Estimated daily steps \pm SE ^a	P value
Car only	10,986 \pm 435	Referent
Bus one way	12,462 \pm 825	.08
Bus only	12,397 \pm 675	.06
Walk one way	12,741 \pm 453	.002
Walk only	13,308 \pm 483	.0002

^a SE corrected for cluster effect by school.

Table 3 Percentage of Students (n = 230) Participating in Each Transport Mode by School

Mode of travel	Total (%)	School 1 (%)	School 2 (%)	School 3 (%)
Car only	34.1	30.7	14.9	67.3
Bus one way	4.3	3.6	2.8	8.0
Bus only	4.5	4.0	3.6	7.1
Walk one way	20.1	22.8	22.0	10.6
Walk only	37.0	38.9	56.7	7.0

Achievement of the 10,000-Steps-Per-Day Criterion

Of the 236 participants, 193 had at least 3 days of pedometer data and were included in this analysis. As shown in Table 4, participants were categorized into 1 of 4 groups depending on the percentage of total days monitored that they achieved the 10,000-step criterion. Few students met the 10,000-step criterion on each day for which they had complete data (ie, the always group), although a substantial proportion (49.7%) did achieve 10,000 steps on at least half (but not all) the days for which they had complete data. Depending on sex and age, between 7.0% and 14.1% of students never met the 10,000-steps-per-day criterion.

Table 4 Percentage of Students (n = 193) Who Meet the 10,000 Step Criterion

Grouping	Never ^a (%)	Sometimes ^b (%)	Often ^c (%)	Always ^d (%)
Total	11.4	24.4	49.7	14.5
Female	13.9	27.0	49.2	9.8
Male	7.0	19.7	50.7	22.5
Juniors	9.6	15.7	54.8	20.0
Seniors	14.1	37.2	42.3	6.4

^a Did not achieve 10,000 steps on any day for which they had complete data.

^b Achieved at least 10,000 steps at least once but on less than half of the days for which they had complete data.

^c Achieved at least 10,000 steps on at least half of the days but not on every day for which they had complete data.

^d Achieved at least 10,000 steps on all days for which they had complete data.

Discussion

Three key findings which were congruent with previous studies emerged. First, total step counts were comparable to those of earlier pedometer-based studies on youth;^{5-8,18} however, the daily steps observed among New Zealand youth fall in the lower end of the step-count spectrum, indicating that youth in this study might be less active than many of their non-New Zealand peers. Second, in support of research showing a sex difference in physical activity, higher physical activity levels were observed in males than in females. Third, a drop in step counts by age group was observed, with junior students accumulating 1657 more steps per day than their senior counterparts. In addition, the accumulated steps were substantially lower than the mean weekdays (boys, 16,133 ± 3864; girls, 14,124 ± 3286) and weekend (boys, 12,702 ± 5048; girls, 11,158 ± 4309) step counts reported in a large sample of New Zealand primary school students.³¹

In support of findings reported by Trost et al²¹ and Klasson-Heggebo et al,²² our data also demonstrates lower physical activity levels on weekend days than on weekdays. Developing out-of-school strategies, therefore, might maximize potential gain in physical activity health promotion for all age groups. This, however, does not preclude the importance of school-day physical activity strategies, especially for seniors, who demonstrate significantly lower levels of physical activity on school

days than their junior peers. A possible contributor to the school-day differential in daily step counts is participation in physical education class. Although physical education is available at each year level during the high school years, physical education is a compulsory subject only for students in years 9 and 10, which in turn might contribute to the higher step counts noticed among the junior age group. Furthermore, strategies targeting habitual activity on school days might be more easily implemented than those targeted at weekend physical activity.

Promoting active transportation as a school-related strategy is further supported by our study, because students walking to and/or from school accrued significantly greater steps than car transit users, a finding reported by previous research using accelerometry.²⁶ The proportion of students walking to school differed substantially between schools. Because school 3 is an integrated Christian school, students are likely to travel from beyond the local school area to attend. This might explain, in part, the substantially higher car user level (and lower level of walking) for students at school 3. Strategies targeting active transportation, therefore, might be a key strategy for some but not all schools, which highlights the need for school-specific strategy development.

A main finding of this study was the proportion of students meeting the physical activity step-based criterion of 10,000 steps daily. Few students, especially females and senior students, achieved 10,000 steps on all days for which each student had available data. Considering the substantial decline in physical activity during adolescence, it is likely that the current youth population will fail to reach the 10,000-step criterion as they enter young adulthood. Although other studies, through the use of accelerometers or questionnaires, have examined the proportion of young people considered active (ie, that is achieving time-based guidelines),³²⁻³⁴ making direct comparisons with the findings noted in this article is difficult for 2 reasons. First, the 10,000-step criterion is not specific to youth and might not correctly classify a teenager as active or not. Second, previous research on both adult- and child-population groups has found difficulty in defining a step threshold that accurately identifies those who meet currently recommended time-based physical activity guidelines.³⁵⁻³⁷ The aim of this study, therefore, was not to examine the proportion of students deemed active, but the proportion reaching 10,000 steps daily, a conservative criterion that should be achieved by young people considering the continuous subsidence of physical activity during the adolescent years.

The findings of the current study must be viewed in light of the following limitations. Although pedometers provide an objective tool to measure physical activity, thereby overcoming the subjective limitations inherent in self-report methods, pedometers are not designed to measure intensity of activity or nonambulatory (eg, swimming) or isometric physical activities. One consequence, therefore, is that we are unable to examine the percentage of students meeting the current moderate-to-vigorous physical activity recommendations.³⁰ Duration and intensity of physical activity participation can be captured through use of accelerometry; however, pedometers provide a less expensive and, therefore, more plausible alternative for gathering objective physical activity data among youth. An advantage of the NL-2000 pedometer (New-Lifestyles Inc) used in this study is that it has an internal clock and data storage capacity to store total step counts at 1-day epoch intervals for a total of 7 days. The pedometer could not, however, provide smaller

epoch intervals, which limits the ability to capture step counts during certain segments of the day without increasing participant or researcher burden.

Because the larger OPIC project purposefully recruited students of low socioeconomic status, the resultant sample for this study (because of size and convenience sampling from the OPIC school sample) is not representative of the New Zealand youth population. In comparison to the high school population of New Zealand, a slightly higher proportion of the sample in this study was female (50% versus 58.5%, respectively). Although ethnicity was not collected from participants, the schools included in this study have a large proportion of Maori and Pacific Island students, 2 key groups that the OPIC project is targeting. At each school, between 67% and 92% of students identified being Maori or Pacific, whereas the ethnic composition for the New Zealand child population (<15 years old) is 7.6% Pacific Island, 24.5% Maori, 62.4% European, and 5.0% Asian. Although convenience sampling is not the gold standard, the sample size and sampling methods we employed are in line with published studies assessing children^{16,38,39} and youth^{6,18} physical activity using pedometers. Although the generalizability of the findings to the New Zealand youth is limited, they are the first published data available on high school students in New Zealand and need to be confirmed through a study using a larger representative sample.

Another limitation is that a large proportion of participants (32.2%) and data points (51.2%) were excluded from the final GEE analysis. Several reasons are likely for the loss of participants and data. Although the use of pedometers that have a memory capacity reduces the participant and researcher burden of recording daily step counts, it also eliminates the potential prompt that daily recording might provide to the participant to wear the pedometer. In addition, conducting research within a high school environment is substantially different than in an elementary school situation. In elementary school, students generally have the same teacher each day, which standardizes pedometer distribution and allows the teacher to provide consistent reminders to wear the pedometer daily. This, however, is not always possible within the high school setting.

Also, it has been suggested that 8 days of monitoring is associated with a reliable estimate of physical activity among adolescents using accelerometers.⁴⁰ This length of monitoring might not always be practical or attainable and might not be directly transferable as an accurate monitoring frame for assessing physical activity using pedometry. Because of the compliance issues with this population group, the GEE-analysis approach was used to maximize the sample size while accounting for the variation in the number of complete data-collection days obtained between participants, which allowed participants with at least 1 weekday of data to be included for analysis. As a result, any potential bias that might have occurred as a result of analyzing only participants with complete data was minimized. When examining the proportion of students achieving the 10,000-step criterion, only those with a minimum of 3 days of data were included for the analysis. Although this monitoring frame might not represent habitual physical activity, it is similar to the monitoring frames used in previous research.^{6,7}

In summary, the current study is the first published study to provide insight into objectively determined physical activity levels and subjectively examined transportation patterns of high school students in New Zealand. Although a large proportion of students do not achieve at least 10,000 steps daily, increasing the level

of student engagement in active transportation, a habitual activity that could be incorporated into the daily routine of students, could assist students in achieving part of their daily activity dose. Strategies that are implemented, however, need to meet the needs of students at specific schools because, at least in our study, substantial differences in active commuting patterns were noticed between schools. Future exploration of objectively determined activity behaviors using a larger sample size is needed, as well as examination of potential correlates of activity among New Zealand high school students. Also, considering the substantially lower levels of physical activity on weekend days, examination of competing sedentary behaviors should be investigated.

Acknowledgments

The authors would like to thank the principals and students of the schools involved in the project. Maea Hohepa acknowledges the financial support, in the form of a PhD Scholarship, of the Health Research Council of New Zealand to conduct this research. Also, the recruitment of schools and participants was facilitated through the Obesity Prevention in Communities (OPIC) project being conducted by the School of Population Health, University of Auckland.

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