Never too old to be active: Investigating the health benefits of older adults being physically active

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List of Acronyms

COI	Cost of Illness
MoH	Ministry of Health 2006/2007 New Zealand Health Survey
N2O	Never 2 Old Active Aging programme
PA	Physical activity
RPA	Regularly physically active
SF-36	Medical Outcomes short form questionnaire

Declaration

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.

Signed .....

Date ……

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Abstract

Background: With the expected growth in the older adult population there is increasing concern as to how health care and health systems will be affected. This concern is driven by the greater prevalence and severity of morbidity, increased mortality and rapid rise in health expenditure that are associated with older adults. Evidence indicates that physical activity is one way in which to modify and improve older adult health, health status and quality of life and an intervention that may be economically advantageous.

Aims: To investigate i) whether participating in the Never 2 Old Active Aging programme (N2O) had an effect on health outcomes, ii) whether these health effects were influenced by the participants level of engagement in this programme and iii) how these health effects might translate into economic measures.

Methods: 225 N2O members, between 55 and 93 years old, were recruited from eleven of the sixteen N2O providers. A single retrospective self-assessed questionnaire was completed in which participants were asked about their physical activity, health status, health care service utilisation, health care expenditure and falls. Study findings were compared to national data collected in the Ministry of Health 2006/2007 New Zealand National Health Survey and between N2O member sub-groups based on differentiated levels of engagement in the programme.

Results: Study results indicate that N2O members who were aged 75yrs or over and female were statistically significantly less likely to be sedentary, as well as statistically significantly more likely to report better self-rated health status, when compared to the Ministry of Health data. Results also suggest that N2O members were ‘relatively’ better than the Ministry of Health comparatives as they had smaller declines in regular physical activity, smaller increases in sedentary behaviour and smaller decreases in self-rated health between successive age groups. These results suggest that involvement in the N2O programme helped members maintain their physical activity and slow the rate of

decline in self-rated health that is generally associated with age. The preliminary economic assessment, using a Cost of Illness approach, estimates that potentially up to 47 deaths could be averted and NZ$130.23million in health expenditure could be saved each year if all older New Zealander adults participated in the N2O programme. However when programme costs were taken into consideration the N2O programme was not shown to be ‘cost effective’.

Conclusion: This study has provided only a simple, provisional snapshot of both the health and economic benefits associated with older adults participating in the N2O programme. A more robust research design and more in-depth quantitative analysis is required to make definitive statements about causal relationships and to accurately measure the range of costs and benefits associated with this intervention. Future research should include control groups and the pre-testing of participants as well as longitudinal and/or ongoing data collection. Such information would be invaluable in identifying the changing health needs of older adults and developing effective physical activity programmes for this populace.

Chapter 1: Introduction

1.1 Background

Older adults (those aged 65 years and over) are now the fasted growing age segment of the population. Last year 12.9% of New Zealand's population were over 65 years of age (Statistics New Zealand, 2011). By the year 2051 this figure will reach 25.5% (Statistics New Zealand, 2006). A major contributor to this demographic shift has been the change in mortality and morbidity patterns. Health concerns have moved away from infectious disease and acute illness to chronic disease and degenerative illness (Omran, 1971). However while we now have an increased life expectancy, equivalent effects in health status or quality of life have not been evident (Statistics New Zealand, 2007). This is primarily due to the increased prevalence and severity of morbidity from chronic disease and degenerative illnesses such as cardiovascular disease, diabetes, cancer and osteoporosis. Morbidity is of particular concern for older adults with statistics indicating 63.8% and 70.3% of older females and males respectively, have between one and three chronic health conditions, with a further 20.6% and 14.8% respectively having four or more (Ministry of Health, 2006).

The greater prevalence and severity of morbidity and increased mortality associated with older adults also means older adults have increased health care utilisation and health care expenditure. Hence, given the expected growth in the older adult population, there is increasing concern as to how health care and health systems will be affected.

While age, genetics and gender contribute to health, modifiable health risk factors have a much more significant effect. The World Health Organisation (2011) identifies unhealthy diet and excessive energy intake, physical inactivity and tobacco use as the three key modifiable health risk factors. These three health risk factors have been linked to many chronic and degenerative diseases and conditions, including heart disease, stroke, chronic respiratory disease and cancer (World Health Organisation, 2011).

Given the leading causes of older adult morbidity, mortality and health expenditure are associated with cardiovascular disease, physical disability and falls, physical activity (PA) has been identified as a way in which to modify and improve older adult health, health status and quality of life. This is based on a

wealth of epidemiological evidence that shows the primary and secondary health prevention role PA has across all ages, including older adults (Carr, 2001; Fiatarone Singh, 2002; Paffenbarger Jr, Hyde, Wing, & Hsieh, 1986).

The physiological benefits gained from older adults engaging in PA have also been shown to translate into economic gains. These economic gains include reductions in health care utilisation (Sari, 2009; Wang, McDonald, Reffitt, & Edington, 2005) and health care expenditure (Ackermann, et al., 2008; G. Yang, et al., 2011). Older adult PA programmes have also been shown to be 'cost effective' (Ackermann, et al., 2003; Leveille, et al., 1998).

The purpose of this thesis is to investigate both the health and economic impact of a New Zealand specific older adult PA programme, Never 2 Old Active Aging programme (N2O).

1.2 Thesis structure

This thesis consists of six chapters. The first chapter provides an introduction to the study, its purpose and aims. Chapter two reviews the literature and presents information that provides both the stimulus and support for this study. The literature review has focused on health, covering older adults, physical activity, and finally economics (which brings together the previous two health areas discussed). Chapter three reviews the methodological approach and the rational for the study design. This chapter also provides information on the N2O programme evaluated in this study. Study results are presented in ten sections as part of chapter four. Section one provides an overview of the study participants. Section two looks at health conditions, an outcome of interest, while sections three through eight cover the dependant variables, being PA, health status, health care service utilisation and health expenditure. Comparisons are made between a pseudo control group and N2O sub-groups within each of these six sections. Section nine provides a summary of the qualitative information gathered on the benefits of the N2O, while section ten looks at N2O costs. Section ten also includes an economic assessment as to the impact of the key results identified in the previous sections. Chapter five discusses the findings. This chapter follows the same format as the results section discussing each dependent variable based on pseudo control group and N2O sub-group comparatives. The concluding chapter summarises the study

and its findings and future directions for research of the N2O as well as for older adults and PA generally.

1.3 Statement of problem

With the anticipated growth in the older adult population comes increasing concern as to how health care and health systems will be affected. This concern is driven by the greater prevalence and severity of morbidity, increased mortality and the rapid rise in health expenditure that is associated with older adults. Consequently finding ways in which to maintain good health and/or improve poor health are important if these concerns are to be addressed.

With the leading causes of older adult morbidity, mortality and health expenditure being associated with cardiovascular disease, physical disability and falls, PA has been identified as one way in which to modify and improve older adult health, health status and quality of life. Evidence indicates that not only do older adults who engage in PA have personal health gains; these gains can have a range of positive economic benefits.

However, as is the case with most research, the diversity found in the literature on such interventions (i.e. type, settings, participants etc.) can make generalisation and transference of programme effects difficult. This is further complicated by the older adults participating in these studies whose health, functional status and quality of life can be quite heterogeneous both within and between studies. Consequently it is essential that research around older adults and PA continues so the 'needs' of older adults can be identified and effective programmes developed. Within the New Zealand context, it is also important to quantify the benefits of local active ageing programmes, such as the N2O, to provide an evidence basis for their utilisation and assist programme providers with improving programme efficacy.

1.4 Aims

The aims of this research are as follows:

1. To investigate whether participation in the Never 2 Old Active Aging programme had an effect on health outcomes.

2. To investigate how Never 2 Old Active Aging programme members' volume (i.e. level of programme engagement, being expressed as attendance hours) affects health outcomes.
3. To investigate the potential economic impact of the Never 2 Old Active Aging programme.

1.5 Significance of research

Undertaking this research was seen as an opportunity to contribute to two areas of knowledge. The first being the role PA plays in the health of older adults', specifically the effects it has on health status, health care service utilisation, health expenditure and falls. The second area was in health economics by performing a preliminary assessment of the economic impact of this programme.

Given that limited research has been undertaken in respect of the N2O, this study was also considered to be of benefit to the N2O, as it would provide:

- Insight into how N2O members fair against national data comparatives in terms of PA, health status, health care service utilisation, health expenditure and falls.
- N2O providers with information on the potential health and economic benefits of the N2O, and therefore provide an additional rational for the continuation of the programme, as well as the support for promotion to other older adults and funders.
- Other exercise and/or PA agencies (e.g., SPARC) and funding providers (e.g., Ministry of Health and Accident Compensation Corporation) with better information about the economic implications of older adults engaging in PA, which may potentially lead to more accessible, and subsidised, PA programmes catering for older adults.

1.6 Hypotheses

1. That the investigation would show N2O members to have better health outcomes than national data comparatives.
2. That greater volumes or levels of engagement in the N2O would lead to better health outcomes.

3. That the preliminary assessment would show the N2O to be economically advantageous.

1.7 Limitations

1. Questionnaire data were self-reported and retrospective (i.e. recall for previous twelve month period). This method is less accurate than a prospective approach due to the limitations associated with respondents remembering events over an extended period of time. None of the respondents' individual data were corroborated with an external source (e.g., health care expenditure were not verified with medical records; N2O attendance was not confirmed with N2O providers).
2. Recruitment of study participants was subject to:
    - The number of consenting N2O providers;
    - N2O members present on the day the researcher visited each consenting N2O centre;
    - N2O provider databases and availability of N2O member details.
3. The study was confined to the Auckland region where N2O providers were located, hence findings may not be generalised to other regions within New Zealand/or internationally.
4. The questionnaire, while based on a national health survey, extracted and used only questions deemed relevant to the research. As no psychometric evaluation of the modified questionnaire was conducted, reliability and validity cannot be assumed.

1.8 Delimitations

1. Study participants were restricted to N2O providers and their members.
2. Data were collected at a single point in time. Neither pre-post comparative data, nor control group comparative data (i.e. those not engaged in the N2O) were collected. Therefore causality cannot be inferred based on the results of this study.
3. The study used a non-randomised approach and self-selected volunteers. Consequently the sample may not be representative of N2O members nor of the older adult population generally.

Chapter 2: Review of literature

2.1 Introduction

New Zealand, like many other countries, is undergoing a demographic transition where older adults (being those 65 plus in age) have become one of the fastest growing population segments (Statistics New Zealand, 2011). It is anticipated that by the year 2051 over one quarter of New Zealand's population will be aged over 60 years (Statistics New Zealand, 2006).

With this expected growth in the older adult population comes increasing concern as to how health care and health systems will be affected. This concern is driven by i) the greater prevalence and severity of morbidity and increased mortality (Fletcher & Lynn, 2002; Ministry of Health, 2006), and ii) the rapid rise in health expenditure that is associated with older adults (Fletcher & Lynn, 2002).

With the leading causes of older adult morbidity, mortality and health expenditure being associated with cardiovascular disease, physical disability and falls, physical activity (PA) has been identified as one way in which to modify and improve older adult health, health status and quality of life. This is based on a wealth of epidemiological evidence that demonstrates the primary and secondary health prevention role PA has across all ages, including older adults (Carr, 2001; Fiatarone Singh, 2002; Paffenbarger Jr, et al., 1986).

Evidence also indicates that older adults' engagement in PA can be of economic benefit. Such economic benefits include reductions in health care utilisation (Sari, 2009; Wang, et al., 2005), reductions in health care expenditure (Ackermann, et al., 2008; G. Yang, et al., 2011) Older adult PA programmes have also been found to be 'cost effective' (Ackermann, et al., 2003; Leveille, et al., 1998).

2.2 Era of change

The combined effects of increased longevity, lower mortality and declining fertility rates now see populations shifting towards the older age groups (Statistics New Zealand, 2007). In 2010 12.9% of New Zealand's population were older adults (Statistics New Zealand, 2011), by the year 2051 it is anticipated to reach 25.5% (Statistics New Zealand, 2006). In addition to this

demographic shift, technological advancements and industrialisation (e.g., better sanitation, advances in medical technology and high calorie foods) have also lead to an epidemiologic revolution. This epidemiologic revolution has altered mortality and morbidity patterns and moved health concerns away from infectious disease and acute illness (such as measles), to chronic and degenerative illness (such as cardiovascular disease) (Omran, 1971).

As a consequence of this epidemiologic revolution life expectancy rates are increasing. Women can now expect to live, on average, 81.1 years and men 76.3 years, while those currently aged 65 years can expect to live a further 20.5 and 17.8 years (females and males respectively) (Statistics New Zealand, 2007). However while life expectancy continues to increase, equivalent effects in health status or quality of life have not been evident. For example, as Table 1 illustrates, between 1996 and 2001 life expectancy (at birth) increased by 1.9 and 1.4 years for males and females respectively. However life with disability also increased, by 1.8 and 1.2 year for males and females respectively, leaving only 0.1 and 0.4 years respectively of this increase in life expectancy as disability free years (Statistics New Zealand, 2007).

Table 1: Health expectancy, by age and gender, 1996 compared to 2001.

Year and age group	Disability free life expectancy (1)	Independent life expectancy (2)	Active life expectancy (3)	Healthy life expectancy (4)	Life Expectancy (5)
Male					
1996					
at birth	57.8	64.7	72.1	67.2	74.4
at 15	45.4	51.6	58.2	53.9	60.2
2001					
at birth	57.9	64.8	73.2	68.1	76.3
at 15	45.3	51.5	59.1	54.5	62.0
Female					
1996					
at birth	60.5	67.5	75.9	70.9	79.7
at 15	47.4	53.8	61.7	57.1	65.4
2001					
at birth	60.9	68.5	77.7	72.0	81.1
at 15	47.7	54.7	63.5	58.1	66.8

(1) Disability free life expectancy is the number of years, on average, that a person can expect to live free of any functional limitation.
(2) Independent life expectancy: is the number of years, on average, that a person can expect to live independently. That is free of functional limitation needing assistance (whether intermittently or on a daily basis).
(3) Active life expectancy is the number of years, on average, that a person can expect to live free of functional limitation needing daily assistance with self-care.
(4) Healthy life expectancy is the equivalent number of years of full health, on average, that a person can be expected to live.
(5) Life expectancy is the average length of life remaining at a given age. Source: New Zealand period life tables 2000-2002.

Source: Ministry of Health 2004, *Longer Life, Better Health? : Trends in health expectancy, 1996-2001*, Public Health Intelligence Bulletin No 23, Ministry of Health, Wellington.

(Statistics New Zealand, 2007, p.75)

2.3 Older adults

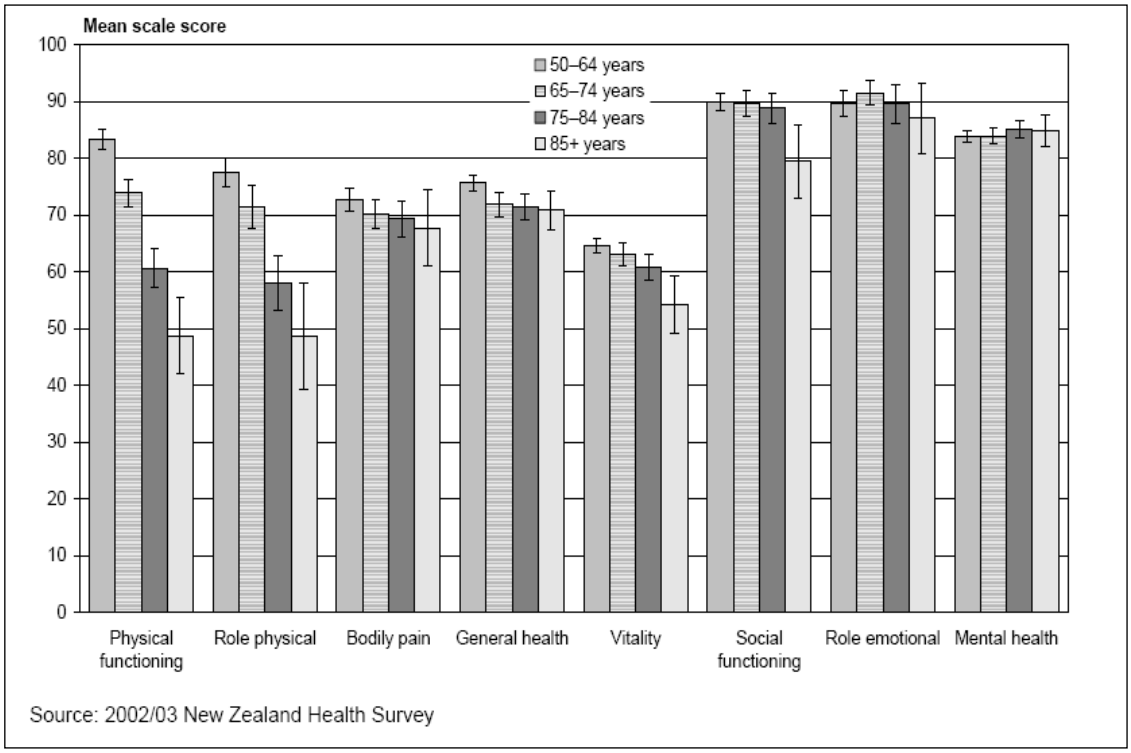
2.3.1 Health status

Ascertaining the health status of older adults can be challenging. The first challenge is in distinguishing between the effects of the biological and physiological changes that occur naturally as part of the aging process, from those that result from disease, disuse and de-conditioning. For example, distinguishing between sarcopenia (i.e. age related muscle mass and function loss) and muscle atrophy due to physical inactivity, or declines in maximal aerobic capacity due to 'normal' aging versus that of inactivity (Chodzko-Zajko, et al., 2009; Fiatarone Singh, 2002). The second challenge faced is the variable effects of genetics, disease, and lifestyle factors that are accumulated over one's life time (e.g., diet, smoking, physical inactivity) (Chodzko-Zajko, et al., 2009). These factors impact on the manner and rate in which individuals 'age' and as a consequence mean older adults' health and health status can be extremely heterogeneous.

Nakasato & Carnes (2006) identify three health dimensions that are of particular interest for older adults. The first, physical function, describes a person's ability to perform basic self-care (e.g., bathing, feeding) and instrumental activities (e.g., housekeeping, meal preparation) associated with daily living. Older adults' physical function is primarily affected by musculoskeletal (e.g., osteoporosis, osteoarthritis, muscle strength and endurance), sensory (vision, hearing), and neurological (balance) factors. The second priority is mental function. Mental function refers to an individual's psychological aspects such as mood, attitude, self-concept, and cognitive ability i.e. memory, thinking, learning and problem solving. The third and final priority, physical health, refers to an individual's ability to avoid disease and disability e.g., diabetes, obesity, cardiovascular disease, cancer, and hypertension.

Self-rated health statuses of older adults indicate that these three health dimensions deteriorate with increasing age. This is shown in Figure 1 whereby greater SF-36 health scores, which indicate better self-rated health, are typically highest in 'younger' older adults. Figure 1 also shows that the key areas of concern for older adults are physical functioning, role physical, vitality and social functioning (Ministry of Health, 2006) (refer section 3.3.3 for definitions of these health scale items).

Figure 1: Self-rated health scores by age. (Survey for Older People, 2000)



(Ministry of Health, 2006, p.29)

2.3.2 Health concerns

Morbidity

Morbidity is defined as a departure from a state of physiological or psychological well-being (Statistics New Zealand, 2004). Given the epidemiologic revolution chronic and degenerative diseases and conditions are the primary cause of morbidity e.g., cardiovascular disease, diabetes, cancer. Morbidity may lead to fatal, non-fatal (e.g., disability) or non-health impacting outcomes (e.g., high blood pressure without symptoms). As older adults have both a greater prevalence of morbidity, as well as increased co-morbidity, morbidity can have a significant effect on older adults. Statistics indicate that 63.8% and 70.3% of older females and males respectively, have between one and three chronic health conditions, with a further 20.6% and 14.8% respectively having four or more (Ministry of Health, 2006). Compared with those aged 50-64 years, those aged 75-84 years are four times and three times (females and males respectively) as likely to have four or more chronic health conditions (Ministry of Health, 2006). Conversely, the percentage of older adults with no chronic health conditions declines from 29% and 32% at age 50-64 years, to 12% and 11% at age 75-84 years (females and males respectively)

(Ministry of Health, 2006). The most prevalent self-reported health condition and cause of morbidity in older adults, for both males and females and across all age groups, is arthritis (refer Table 2), with high prevalence rates also being found in heart disease and spinal disorders.

Table 2: Prevalent diseases and conditions of older adult morbidity

Indicator	Females						Males					
self-reported, percent	65–74 years		75–84 years		85+ years		65–74 years		75–84 years		85+ years	
	RC	PD	RC	PD	RC	PD	RC	PD	RC	PD	RC	PD
Heart disease	32.0 (14.1, 49.9)	26.5 (22.7, 30.2)	39.7 (30.0, 49.5)	38.9 (33.0, 44.8)	39.6 (33.8, 45.4)	41.6 (32.0, 51.2)	36.9 (24.6, 49.3)	33.1 (27.3, 38.9)	44.5 (33.6, 55.4)	43.8 (37.0, 50.7)	42.0 (29.1, 55.0)	34.3 (15.1, 53.5)
Stroke	–	3.7 (1.9, 5.5)	24.9 (18.3, 31.4)	12.2 (8.4, 15.9)	24.7 (19.1, 30.2)	10.9 (5.4, 16.3)	39.1 (26.5, 51.8)	8.8 (4.8, 12.9)	29.8 (19.4, 40.3)	11.8 (6.9, 16.7)	22.2 (12.1, 32.2)	–
Cancer	–	18.4 (14.2, 22.6)	15.6 (9.1, 22.0)	20.1 (15.6, 24.6)	15.8 (11.6, 20.1)	22.2 (9.7, 34.8)	–	19.7 (14.3, 25.2)	17.7 (9.5, 26.0)	28.8 (22.7, 34.9)	28.8 (16.3, 41.3)	33.1 (17.5, 48.8)
COPD	–	8.1 (5.3, 11.0)	9.9 (5.5, 14.3)	8.5 (5.1, 11.9)	4.9 (2.2, 7.5)	–	–	6.7 (3.5, 9.8)	14.5 (6.4, 22.7)	10.2 (5.4, 14.9)	–	–
Diabetes	30.6 (13.8, 47.3)	11.7 (8.1, 15.4)	17.4 (10.7, 24.1)	10.5 (6.9, 14.0)	8.5 (5.0, 11.9)	–	29.1 (16.5, 41.7)	14.9 (10.4, 19.3)	12.0 (5.0, 19.0)	10.8 (6.3, 15.3)	–	–
Arthritis	53.3 (36.3, 70.2)	52.6 (47.2, 57.9)	48.0 (38.5, 57.6)	55.4 (49.6, 61.3)	51.3 (44.6, 58.0)	52.1 (41.2, 63.0)	33.5 (16.7, 50.3)	38.5 (32.6, 44.5)	29.6 (18.5, 40.6)	46.9 (40.4, 53.4)	39.4 (27.9, 50.9)	54.5 (36.2, 72.8)
Spinal disorders	28.6 (11.6, 45.5)	39.8 (35.2, 44.4)	27.3 (18.8, 35.7)	30.1 (25.5, 34.8)	29.7 (22.6, 36.7)	31.3 (21.6, 40.9)	23.8 (11.3, 36.3)	34.8 (28.9, 40.6)	19.1 (8.2, 30.0)	31.9 (25.5, 38.4)	23.0 (13.5, 32.5)	28.3 (16.0, 40.6)
Osteoporosis	–	13.9 (10.5, 17.3)	18.7 (12.8, 24.6)	18.3 (13.9, 22.7)	22.2 (16.9, 27.5)	17.0 (10.8, 23.3)	–	–	–	–	–	–

Source: 2002/03 New Zealand Health Survey

Note:

- – indicates that the count was fewer than 10, and therefore the rate was not calculated.
- Numbers in brackets indicate the 95% confidence intervals.

Note RC = Residential Care, PD= Private Dwelling

(Ministry of Health, 2006, p.96)

Disability

Broadly a disability is described as a restriction or lack of ability to perform an activity in a manner or way which would be considered normal for a human being (World Health Organisation, 2011). Disability is of particular concern for older adults, as not only can it limit an individual's capacity and capabilities, but it can also influence independence and impact on end of life suffering (Statistics New Zealand, 1998). Older adults are three times more likely to have a disability than those less than 65 years, with 73% having

multiple disabilities (Statistics New Zealand, 2004). In addition to the increasing prevalence and severity of disabilities that occur with advancing age (Fletcher & Lynn, 2002), more than half (54%) of all older adults will have their disability for ten or more years (Statistics New Zealand, 2004).

The most common causes of disability, as identified by older adults, are disease/illness (37%), 'aging' (21%), and accident/injury (16%) (Statistics New Zealand, 2004). Physical disability in older adults accounts for 66% of all disability (Statistics New Zealand, 2004), with the main forms being limitations in mobility and agility (refer Table 3).

Table 3: Types of disability for people 65 and over by residential status 2001.

Type of disability	Household (rates per 1000 household population)	Residential care (rates per 1000 residential care population)	Total
Mobility	382	914	413
Agility	295	887	329
Partially sighted/blind	77	452	99
Hearing impaired/deaf	221	404	231
Speaking	28	272	42
Remembering	68	533	95
Learning disability	29	480	55
Psychiatric/psychological	25	327	42
Intellectual	9	106	15
Disability type not elsewhere classified	80	154	84

Source: Statistics New Zealand 2001 Household Disability Survey and 2001 Disability Survey of Residential Facilities

(Ministry of Health, 2002, p.54)

Falls

A major cause of older adult disability is falls. Not only do older adults have a greater risk of falling than younger adults, but this risk increases with age. Campbell, Reinken, Allan, & Martinez (1981) prospective study of older New Zealand adults found that 34% of their participants reported at least one fall during the 12 month reporting period. Campbell, Reinken, Allan, & Martinez (1981) also found that fall rates generally increased with age (25% at 65-74 years; 44.3% at 75-79 years; 42% at 80-84 years; 50% at 85-89 years; 56% at 90+ years). Accident Compensation Corporation (2005) data indicates similar

trends, with one third of those aged 65 years and older having a fall, increasing to one in two by 80 years of age.

In addition to an increased risk of falling older adults also have an increased risk of not only injury, but severe injury, from falling. Tinetti, Speechley, & Ginter (1988), for example, found that 25% of older adult falls lead to serious injury. With older adults increased vulnerability to and injury from falls the chance of requiring hospitalisation and/or sustaining a fracture (particularly a hip fracture) also increases. Accident Compensation Corporation (2005) data estimates that 55% of all hospitalised unintentional injuries are the result of falls in people aged 65 to 69 years. For those aged 70 to 74 years this increases to 65%, reaching 85% for those aged 75 years and older.

Many older adults who suffer a fall experience a dramatic decline in physical function through physical and/or psychological disability e.g., limited mobility; post-fall fear of falling; loss of confidence; self-imposed functional limitations and restrictions in activity (Accident Compensation Corporation, 2005; American Geriatrics Society, 2001; Vellas, Wayne, Romero, Baumgartner, & Garry, 1997). Furthermore those who suffer a hip fracture are four times more likely to have limited mobility and more than twice as likely to be functionally dependent (Accident Compensation Corporation, 2005). It is also estimate that 20% of all older adults who sustain a hip fracture die within a year of the event (Accident Compensation Corporation, 2005).

Risk factors associated with falls can be classified as extrinsic (i.e. environmental hazards such as inadequate lighting or uneven surfaces) or intrinsic (i.e. an individual's physical function and capacity, for example vision, balance or muscle strength) (Akyol, 2007; American Geriatrics Society, 2001; Masud & Morris, 2001). While extrinsic factors are associated with 33% to 50% of falls (Akyol, 2007), it is a lack of 'physical reserve' and older adults inability to adapt to a change in conditions or 'challenge', which ultimately result in a fall (Petrella & Cress, 2004). Specifically, older adults may take longer to realize their loss of balance, take longer to initiate the correct response and have insufficient lower body muscular strength and power to regain balance after taking a step.

Mortality

Inevitably with increased morbidity comes increased mortality. Nearly 78% of all deaths in 2001 were people aged 65 years and over (Statistics New Zealand, 2004). The high prevalence of morbidity among older adults also mean that most older adults die with, if not from, multiple chronic diseases. Cardiovascular related diseases (i.e. forms of heart and blood vessels disorders) are the leading causes of death in older adults, accounting for 43% of all older adult deaths in 1999 (refer Table 4) (Statistics New Zealand, 2004).

Table 4: Five most common causes of death for 65 years and over (Mortality and Demographic Data 1999).

Population aged 65 years and over	Percentage of deaths
Ischaemic heart disease*	26
Total malignant neoplasms*	25
Cerebrovascular disease*	12
Chronic obstructive pulmonary disease and allied conditions*	8
Other forms of heart disease*	5

* chronic disease

(Statistics New Zealand, 2004, p.52)

2.3.3 Health risk factors

While non-modifiable risk factors such as age, genetics and gender contribute to health and health status, modifiable health risk factors have a much more significant effect. Extensive evidence from a range of laboratory, clinical and population-based studies show that a small set of modifiable health risk factors are responsible for most morbidity (see Table 5) (World Health, 2004). The top three modifiable health risk factors are an unhealthy diet and excessive energy intake, physical inactivity and tobacco use (World Health Organisation, 2011). The World Health Organisation (2011) identifies these three health risk factors as the main cause of chronic and degenerative diseases and conditions, particularly heart disease, stroke, chronic respiratory disease and cancer. The Ministry of Health (2003) estimate that 80% of cardiovascular disease cases in New Zealand are related to these three modifiable health risk factors. The effects of these three modifiable health risk factors appear as intermediate risks such as raised blood pressure

(hypertension); raised blood glucose (associated with diabetes); raised blood lipids and cholesterol, and excess weight (obesity) (Ministry of Health, 2003).

Table 5: Top ten leading causes of attributable global mortality and burden of disease (World Health Organisation, 2004).

Attributable Mortality	Percentage attributable to mortality
1. High blood pressure	12.8%
2. Tobacco use	8.7 %
3. High blood glucose	5.8 %
4. Physical Inactivity	5.5 %
5. Overweigh and obesity	4.8%
6. High cholesterol	4.5%
7. Unsafe sex	4.0%
8. Alcohol use	3.8%
9. Childhood underweight	3.8%
10. Indoor smoke from solid fuel	3.3%
59 million total global deaths in 2004	

(World Health Organisation, 2004)

The prevalence of modifiable and intermediate risk factors for the older adult population, and the relative risk each factor makes to cardiovascular disease are shown in Table 6. For those with multiple risk factors the absolute risk is greater, being more than the mere accumulation of individual risk factors added together (Ministry of Health, 2003).

Table 6: Older adult risk factors and their association with cardiovascular disease.

Risk factor	Prevalence females	Prevalence males	Increase in risk of cardiovascular disease
Cigarette smoking	10%	9.1%	2-3 times
Hypertension (blood pressure)	65–74yrs 53%, increasing to 72% for those 75yrs and over	65–74yrs 60%, increasing to 66% for those 75yrs and over	2–3 % for each 1 mm Hg increase in systolic blood pressure
Diabetes (blood glucose) Note these are only diagnosed cases	12.9%	15.7%	2-3 times men; 4-5 times women (premenopausal)
Overweight or obese	41.4%	70.5%	2-3 times
Physical inactivity (Sedentary)	27.6%	23%	1.9 times

(Ministry of Health, 2003; Statistics New Zealand, 2004)

2.4 Physical activity

2.4.1 Definition

Physical activity is defined as “any bodily movement that is produced by the contraction of skeletal muscle that increases energy expenditure above a basal level” (Caspersen, Powell, & Christenson, 1985). Physical activity can be characterised by five domains, these being intensity; frequency; duration; context (i.e. the purpose or circumstances in which it is performed, such as leisure, occupational, transport) and mode (i.e. type, such as cardiovascular or resistance, or walking or cycling) (Exercise and Physical Activity Resource Center, 2011). Consequently, given these five PA domains, PA is a complex and multidimensional activity which can include various bodily movements done incidentally as part of daily living (e.g., house chores), recreationally during leisure time, as part of one’s work, or as planned exercise.

2.4.2 Participation and recommendations

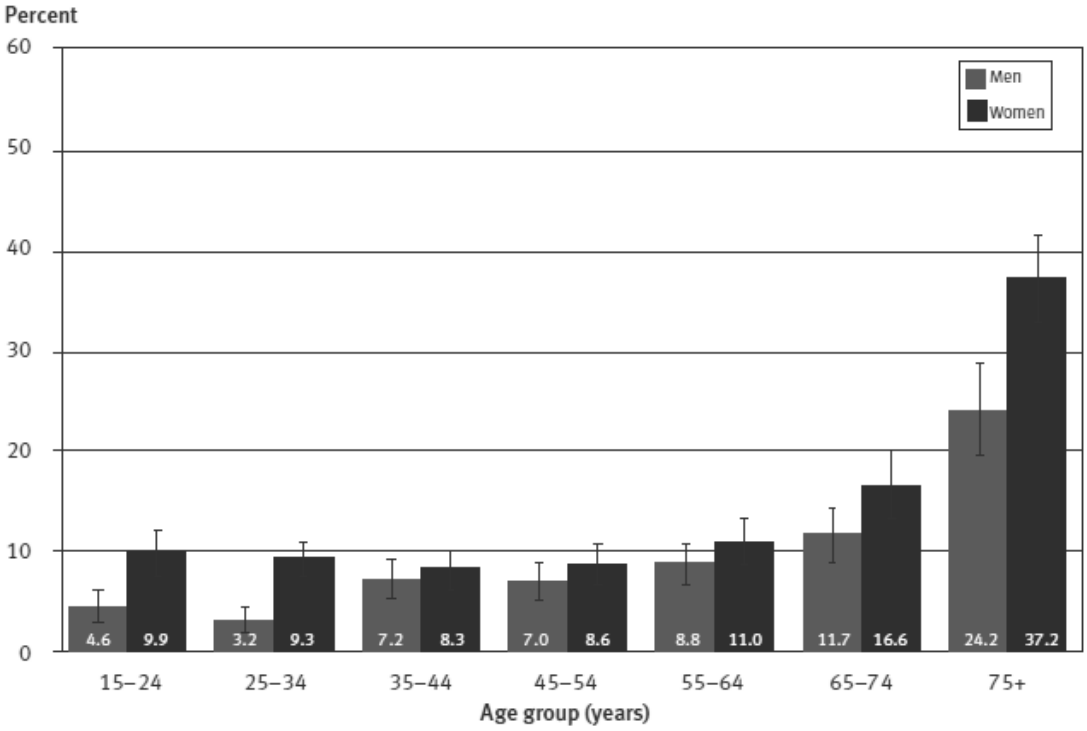
Nearly one third (32%) of New Zealand adults are inactive (Van Aalst, Kazakov, & McLean, 2003). Older adults are of particular concern because of their lower levels of PA and greater levels of sedentary behaviour. Evidence indicates that older adult PA continues to decline and sedentary behaviour continues to increase with advancing age, particularly amongst females and those aged 75+ years (refer Figure 2) (Ministry of Health, 2008).

With cardiovascular disease being the leading cause of death, PA guidelines have tended to focus on cardiovascular health. The current PA recommendation for adults is to do at least 30 minutes of moderate PA on most days of the week, with extra health benefits to be gained if this is increased to 60 minutes (Ministry of Health, 2003a). While cardiovascular health is important, the 'level' or 'type' of PA required, or of most benefit, is often dependant on the health condition(s) that an individual has or is at risk of developing. For example, osteoporosis requires weight-bearing activities; obesity necessitates increasing calorie expenditure, while cardiovascular health demands cardio-respiratory activities. Hence for older adults there is growing recognition as to the importance of musculoskeletal considerations.

The American College of Sports Medicine has put forward a position statement which recommends that older adults engage regularly in both aerobic and muscle strengthening PA in order to maintain and improve their health and wellbeing (Chodzko-Zajko, et al., 2009). These recommendations include: i) 30 minutes of moderate intensity aerobic five days a week OR 20 minutes of vigorous intensity aerobic three days a week; ii) eight to ten strength training exercises of 10-15 repetitions two or three times a week; and iii) balance exercises for those at risk of falling (Chodzko-Zajko, et al., 2009).

These recommendations are based on a wide range of epidemiological evidence and randomised controlled trials which have demonstrated the positive effects of these forms of PA for older adults. These effects include, for example, improved body composition such as reductions in body fat and/or greater muscle mass; higher bone mineral density; improved cardiovascular 'fitness' e.g., lower heart rate at rest and during exercise and improved coronary risk profile e.g., lower blood pressure, better insulin sensitivity, lower cholesterol (Chodzko-Zajko, et al., 2009).

Figure 2: Sedentary adults by age and gender.



Source: 2006/07 New Zealand Health Survey

(Ministry of Health, 2008, p.6)

2.4.3 Modifiable health risk

Physical activity is identified by the Ministry of Health (2003a) as second only to smoking as a key risk factor for poor health. In recent decades, there has been a great deal of research undertaken investigating the relationship between PA and health. A large body of epidemiological evidence now exists which shows the value and versatility of PA as both a primary (i.e. protective and preventative) and secondary (i.e. management and treatment) 'health tool' (Chodzko-Zajko, et al., 2009).

While no amount of PA can stop the biological effects of aging, evidence indicates that PA can minimise the physiological and quality of life effects (i.e. structural and functional deterioration of tissues, organs, functions such as loss of muscle mass) (Chodzko-Zajko, et al., 2009). Furthermore, as Table 7 shows, the physiological changes that occur as a result of being physically active also affect health through the modification of intermediate risk factors such as blood pressure and metabolic function (Ministry of Health, 2003a). Consequently, being physically active can also alter the course of many diseases and disabilities, as well as help increase quality of life and preserve functional ability

and independence (Christensen, Stovring, Schultz Larsen, Schroll, & Avlund, 2006).

Table 7: Physiological changes associated with age and exercise.

Physiological Parameter	Aging/Disuse Effect	Physical Activity/Exercise Effect
Exercise/Work Capacity		
Maximal aerobic capacity	Decrease	Increase
Heart rate and blood pressure response to submaximal exercise	Increase	Decrease
Maximal heart rate	Decrease	No change
Tissue elasticity	Decrease	Increase
Muscle strength, power, endurance	Decrease	Increase
Motor coordination	Decrease	Increase
Neural reaction time	Decrease	Increase
Oxidative and glycolytic enzyme capacity, mitochondrial volume density	Decrease	Increase
Gait speed, step length, cadence, gait stability	Decrease	Increase
Cardiovascular Function		
Resting heart rate	No change	No change or decrease
Maximal cardiac output	Decrease	Increase*
Endothelial reactivity	Decrease	Increase
Maximal skeletal muscle blood flow	Decrease	Increase
Capillary density	Decrease	Increase
Arterial distensibility	Decrease	Increase
Vascular insulin sensitivity	Decrease	Increase
Plasma volume, hematocrit	No change, decrease	Increase
Impaired baroreflex function, postural hypotension in response to stress	Increase	Decrease
Pulmonary Function		
Vital capacity	Decrease	No change
Maximal flow rates	Decrease	No change, increase
Nutritional Status		
Resting metabolic rate	Decrease	No change, increase
Total energy expenditure	Decrease	Increase
Thermic effect of meals	Decrease, no change	Increase, no change
Total body water	Decrease	Increase
Total body potassium, nitrogen, calcium	Decrease	Increase
Protein synthesis rate, amino acid uptake into skeletal muscle, nitrogen retention, protein turnover	Decrease	Increase
Gastrointestinal transit time	Decrease	Increase
Appetite, energy intake	Decrease, no change	Increase, no change
Metabolic, Miscellaneous		
Glycogen storage capacity, glycogen synthase, GLUT-4 transporter protein content, and translocation to membrane	Decrease	Increase
Lipoprotein lipase activity	Decrease	Increase
Total cholesterol, LDL cholesterol	Increase	Decrease or no change
HDL cholesterol	Decrease or no change	Increase or no change
Hormonal and sympathetic nervous system response to stress	Increase	Decrease
Growth hormone, IGF-1	Decrease	Increase, no change
REM and slow wave sleep duration	Decrease	Increase
Heat and cold tolerance, temperature regulatory ability	Decrease	Increase
Cognitive processing speed, accuracy	Decrease	No change, increase
Attention span	Decrease	Increase
Memory	No change, decrease	No change
Glomerular filtration rate	Decrease	No change

Notes: LDL = low-density lipoprotein; HDL = high-density lipoprotein; IGF-1 = insulin-like growth factor 1; REM = rapid eye movement. Aging/Disuse effects are not completely separable in most studies. Direction of effects represents a synthesis of the findings in a majority of the available observational and experimental data in each domain.

*Due to changes in exercise-augmented cardiac contractility and stroke volume; observed only in endurance-trained men so far.

(Fiatarone Singh, 2002, p.M264)

The association between PA and both morbidity and mortality has been well documented. Engaging in PA has been shown to have an “all cause” effect i.e. death from any cause. Several prospective cohort studies have shown that those who engage in PA have a lower mortality risk than those who are sedentary. For example Paffenbarger, et al., (1986) 16-year cohort study of 16,936 males (aged 35 to 74), found all-cause mortality rates were 28% lower among those who were physically active compared to those who were inactive. This was irrespective of other risk factors including hypertension and smoking. Leon, Connett, Jacobs Jr, & Rauramaa (1987) found similar results in a seven year follow-up of middle aged men, whereby there were 30% fewer deaths in those men who were classified as moderately physically active in their leisure time compared to those who were classified as low.

Likewise for women Lissner, Bengtsson, Bjorkelund, & Wedel (1996) six year follow-up of 1,405 women, aged 38-60 years, found the relative risk of mortality associated with being active was reduced to 0.56 compared to those who were inactive. Interestingly Lissner, Bengtsson, Bjorkelund, & Wedel (1996) also found that decreasing PA was a significant risk factor for all-cause mortality, equating to a relative risk of 2.07 (i.e. those women who decreased their PA over the six years increased their relative risk). Hence both decreases in PA as well as low PA levels were identified as strong risk factors for mortality and women. Similarly Kushi, et al., (1997) seven year prospective cohort study of 40,417 post-menopausal women (aged 55-69 years) found those women who were regularly physically active significantly reduced their risk of death compared to those who were not (relative risk of 0.77). While Kushi, et al., (1997) also found that increasing frequency of moderate PA and vigorous PA reduced relative risk of mortality, they found that even moderate PA done as infrequently as once a week showed a reduced mortality risk of 0.78. These dose response effects were also found by Oguma, Sesso, Paffenbarger & Lee (2002). Oguma, Sesso, Paffenbarger & Lee (2002) review of PA on all-cause mortality effects in women found a median risk reduction of 34% for those who were physically active. Oguma, Sesso, Paffenbarger & Lee (2002) also found a dose response effect whereby all-cause mortality declined with increasing levels of PA, the difference being at least 20% between death rates of the most active and least active women.

These reductions in mortality have also been found to hold true for older populations. For example Paffenbarger, et al., (1986) found older men that were highly active had half the mortality risks of those that were inactive. Oguma, Sesso, Paffenbarger & Lee (2002) found similar results in women aged 65+ years, whereby the median relative risk, comparing most active with least active women, was 0.58 i.e. a 58% reduction in mortality risk.

There is also a vast amount of evidence as to effects of PA in respect to chronic disease and degenerative illness. Lee (2003), for example, found a 30%-40% reduction in the relative risk of colon cancer for physically active men and a 20%-30% reduction in the relative risk of breast cancer for physically active women compared with their inactive counterparts. Wolff, Van Croonenborg, Kemper, Kostense, & Twisk (1999) found exercise prevented or reversed almost 1% of bone loss per year in the lumbar spine and femoral neck in both pre and post-menopausal women.

Likewise evidence also indicates PA can have benefits for 'general health'. Mazzeo & Tanaka (2001), Fiatarone Singh (2002) and Singh (2004) all found that older adults who engaged in regular PA improved their physical function and functional capabilities i.e. balance, strength, coordination and motor control, flexibility and endurance, while Carr (2001) found psychological improvements, such as mental health, cognitive function, and the management of disorders e.g., depression and anxiety. Acree, et al., (2006) also found, using the SF-36, significantly higher self-rated health scores in all eight domains in those that reported higher PA levels compared to those with low PA levels. Even after adjusting for gender and hypertension, SF-36 scores remained significantly higher in physical function, role physical, bodily pain, vitality and social functioning in those with higher levels of PA. Table 8 shows the effects of PA on a range of health conditions and diseases that can affect older adults.

Table 8: Effects of PA on health conditions and diseases.

Condition	Reducing Risk	Reduce Symptoms	Improve Outcome	Type of Activity
Alzheimer's Disease	+			A
Anxiety	+ +	+ +	+ + +	A
Asthma	+	+ +		A
CHD	+ + +	+ + +	+ +	A, E
CORD	+	+ +	+	A
CVA (stroke)	+	+ +	+ +	S, A*
Cancer:				
Breast	+ +	+	+ +	A
Colon	+ + +	+ +	+ +	A
Endometrium	+			A
Lung	+			A
Prostate	+	+	+ +	A
Depression	+ +	+ +	+ +	A
Diabetes (Type 2)	+ + +	+ + +	+ + +	A, E
Hypertension	+ +		+ + +	A, E
Longevity		+ + +	+ + +	A
Obesity	+ +	+ +	+ + +	E, A
Osteoarthritis		+	+	S, A
Osteoporosis	+ +			S (W), A
Peripheral vascular disease		+		A
Pregnancy		+	+ +	A
Smoking	+	+ +	+ +	A
Stress	+ +	+ +	+ +	A
Ulcer, Duodenal	+ +			A

Key: + evidence suggests a small effect; + + moderate effect; + + + large effect
A = Moderate activity; E = energy expenditure important; S = strength exercises; W= weight bearing activity
This table comments on the strength of effect of PA in published studies, not on the strength of evidence.
* Stroke – Moderate activity is important in stroke prevention; strength exercise is important in the rehabilitation post-CVA.

(Carr, 2001, p.7)

2.5 Economic burden, cost and benefit

With increasing budgetary pressure being placed on the health sector, as well as more stringent performance targets, the question of what health services should be provided, and for whom, are increasingly contentious and controversial issues. It is the need to make such decisions in environments where there is uncertainty, scarce resources, multiple choices and competing priorities that has made the use of economic evaluations increasingly popular within health care. While economic evaluations can take various forms their function remains the same, that is to determine the most efficient and effective way to use the limited health care resources available. Consequently, while evidence shows PA can offer a wide range of individual physiological benefits that can improve health, PA must also be shown to be economically advantageous. Such economic considerations have implications for health care

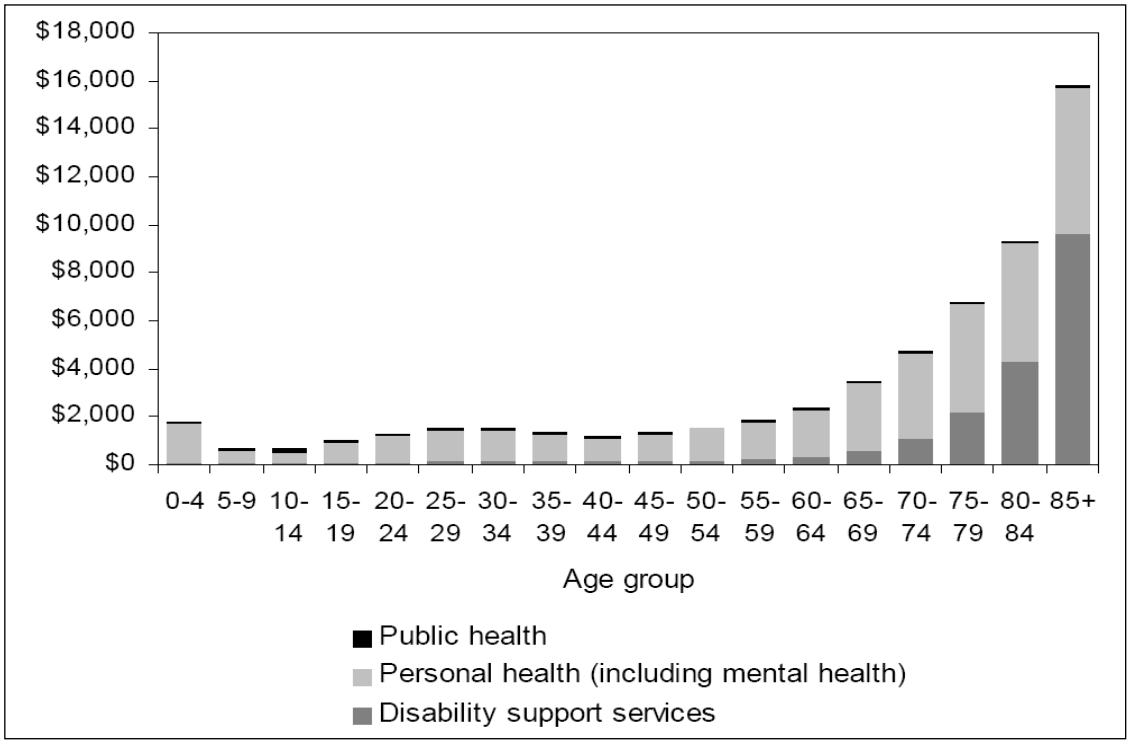
programmes and initiatives, including those for older adults, which will likely be contingent on proving an economic benefit rather than just physiological health benefits.

2.5.1 Older adults

Health expenditure

Bryant, Teasdale, Tobias, Cheung, & McHugh (2004) estimate that older adults in New Zealand cost the health system five times as much as those aged under 65 years. Older adults currently account for approximately 40% of total government health expenditure, which is anticipated to increase to 63% by the year 2051 (Bryant, et al., 2004). Per capita costs and health service utilisation rates also increase incrementally with age. This is due, in main, to an increase in the prevalence of chronic diseases and disability found in older adults, the greater complexity of health conditions, the greater treatment costs and longer lengths of hospital stays (Fletcher & Lynn, 2002).

Figure 3: Annual per capita government health expenditure by age and service group (males and females combined), 2001/2002



(Bryant, Teasdale, Tobias, Cheung & McHugh, 2004, p.3)

Note public health refers to 'national' expenditure such as national campaigns for anti-smoking.

As Figure 3 shows, per capita health expenditure increases exponentially from age 65 onwards. The main source of this increase is in personal health (i.e. primary, secondary and tertiary medical care) and disability support services (i.e. home support and residential care). The most marked increase is in disability support, which accounts for 61% of all health expenditure by age 81 (Bryant, et al., 2004). Likewise, those aged 85 plus are twice as likely as those aged under 65 years to visit their general practitioner over ten times per annum, while 32% of all hospital visits are from people aged 65 and over (Fletcher & Lynn, 2002). Table 9 provides a summary of health service utilisation and per capita costs for older adults.

Table 9: Summary of health service utilisation and per capita costs for older adults

Age Group	Average number of GP visits per year	Average number of scripts per year	Hospitalisation rate	Average medical/ surgical cost	Annual per capita expenditure (publicly funded services)
65-74	6(M), 7(F)	17(M), 20(F)	26%	$940	$3,643
75-84	8	22(M), 23(F)	39.7%	$1,562	$6,863
85 +	9	30	53.4%	$2,066	$13,568

M=male; F=female
(Ministry of Health, 2002)

Impact of ill health

While data show that health expenditure rises rapidly after age 65, evidence suggests that age, per se, is not necessarily the cause, but rather the prevalence of chronic diseases and disability, and the risk of dying, both of which increase exponentially with age (Ministry of Health, 2004; Z. Yang, Norton, & Stearns, 2003). Three theories have been put forward to explain the possible mechanisms of this phenomenon. The first theory, proposed by Gruenberg (1977), suggests that the epidemiological revolution has resulted in a expansion of morbidity. Expansion of morbidity is associated with advances in medical care that have increased life expectancy and the amount of time that a person lives with, or suffers from, a chronic disease. Subsequently there are

not only increased numbers of people who are chronically ill or disabled, but these diseases and disabilities must also be borne for a longer period of time during later years of life.

This is in contrast to the second theory proposed by Fries (1980, 1983) which suggests that the epidemiological revolution has resulted in a compression of morbidity. Compression of morbidity purports that the onset of chronic diseases occurs at an older age and hence 'squeezes' all the morbidity of one's lifetime into a shorter period that is closer to time of death (i.e. a period of disability and dependence compressed into later life).

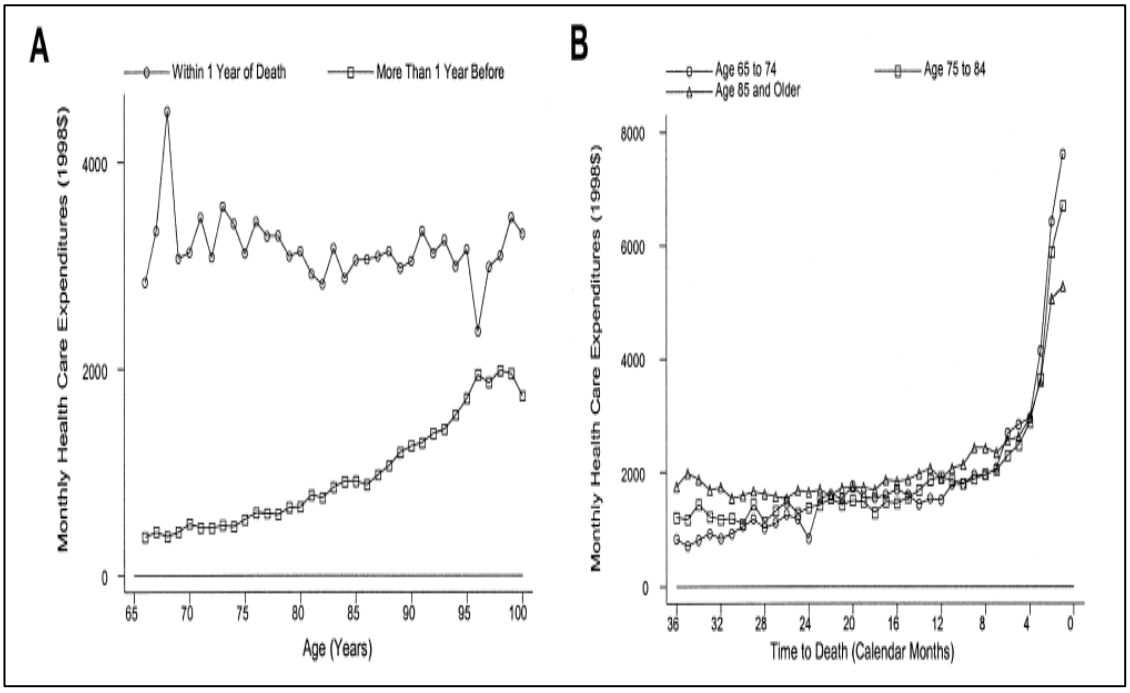
The third theory, proposed by Manton (1982), suggests a combination of compression and expansion of morbidity. Manton (1982) advocates a state of dynamic equilibrium, in which the proportion of life spent with serious disabling disease decreases, but the proportion of life with less severe disease increases.

Time or distance to death has also been identified as a possible reason for older adults increased health expenditure. Zweifel, Felder, & Meiers (1999), Miller (2001) and Yang (2003) all found that for those aged 65 and over it was 'time-to-death' or 'distance-to-death' that influenced health expenditure. Zweifel, Felder, & Meiers (1999), Miller (2001) and Yang (2003) each found that one quarter or more of lifetime health expenditure was consumed in the last year of life. Miller (2001), for example, found that 95 year olds who were 9 years from death cost an average US$2,100 per annum while a 75 year old in their last year of life cost more than six times as much (US$13,500). Lubitz, Cai, Kramarow, & Lentzner (2003) also found that an average 70 year old in good health, with a life expectancy of 14.3 years accumulated US$136,000 in health costs during their final 14.3 years (US$9,510/annum). In contrast, a person of the same age with one 'limitation', and a reduced life expectancy of 11.6 years, accumulated US$145,000 during their final 11.6 years (US$12,500/annum). This equated to a difference in accumulated health costs of US$9,000. Lubitz, Cai, Kramarow, & Lentzner (2003) suggests this increase in health expenditure with decreasing time to death reflects the premise that those closer to death tend to be 'sicker' and consequently require and utilise more health care. Hence, as suggested by Zweifel, et al.,(1999), the positive relationship between age and health care expenditure may be explained by the simple fact that there is a higher probability of dying with advancing age (i.e., at age 80 there are

more individuals living in their last years of life than those at age 65) (Refer Figure 4).

Each of these three theories proposes different explanations as to why the health expenditure of older adults increases, the underlying concept of maintaining and/or improving health and health status as a means of managing the health expenditure of older adults is a common feature i.e. a person in good health 'costs less' than someone in poor health (even though they live longer).

Figure 4: A Health care expenditure by age and time to death; B Health care expenditure by time to death and age.



(Yang, 2003, p.S7)

2.5.2 Physical inactivity

Burden and cost - physical inactivity

Given the many determinants that independently and additively affect health, determining the true cost of physical inactivity is difficult. The Ministry of Health (2003a) estimate that 8% of all deaths (approximately 2000 people) per year in New Zealand are associated with physical inactivity. However this figure may be significantly underestimated given the difficulty in measuring population based PA (Ministry of Health, 2004).

An indication of the economic cost of physical inactivity can be gained from reviewing the health expenditure of those diseases, intermediary risk

factors and disabilities that can be modified through PA. For example it is estimated that the total direct annual cost of osteoporosis in New Zealand is NZ$331million (P. Brown, McNeill, Leung, Radwan, & Willingale, 2011; P. Brown & UniServices, 2007). This includes up of $212million used to treat fractures, $85million for fracture after care and $34million for treatment and management of the estimated 70,631 people diagnosed with osteoporosis (P. Brown, et al., 2011; P. Brown & UniServices, 2007). Swinburn, et al., (1997) estimate that NZ$135million of direct health care expenditure could be attributed to obesity. The three key contributors identified were non-insulin dependent diabetes ($42million), coronary heart disease ($41million) and hypertension ($37million). Chan, Jackson & Papa (2010) also suggest that an estimated NZ$97million of additional pharmaceutical, laboratory and hospitalisation direct health costs are incurred for the estimated 40,910 Counties Manukau residents with cardiovascular disease and/or diabetes. The Accident Compensation Corporation (2005) also estimate that NZ$105million per year is spent on the treatment and rehabilitation of injuries due to falls.

In addition to the direct health expenditure, as indicated above, there is likely substantial indirect health care expenditure associated with physical inactivity. These indirect health care expenditures included i) lost productivity due to absence from work or 'unfitness', ii) 'voluntary' care such as transport and assistance provided 'free' by relatives, and iii) 'intangible' costs like impaired quality of life that affect both the lives of the individual and their relatives (Swinburn, et al., 1997). As an example Swinburn, et al., (1997) estimated that the indirect and intangible costs for coronary heart disease could add an additional 80% to 180% to this diseases direct costs.

It is also likely, given the growing trend which now sees some chronic diseases starting to 'develop' in childhood, that health care expenditure will continue to rise. An example of this is the 'obesity epidemic'. Statistics indicate that 8.3% and 20.9% of children (aged between 2 and 14 years) are obese or overweight respectively (Ministry of Health, 2008). Evidence indicates that being overweight as a child increases the risk of developing chronic diseases in adulthood (such as diabetes, high blood pressure, high cholesterol) (Centers for Disease Control and Prevention, 2011). Being overweight as a child also increases the chance of being or becoming overweight or obese as an adult (up

to 70% increase), which further increases the risk of developing chronic diseases (Centers for Disease Control and Prevention, 2011).

In an attempt to determine the economic impact of physical inactivity several economic approaches have been developed. One such approach is Cost of illness (COI). The principle aim of COI analysis is to evaluate the economic burden that poor health and poor health behaviours impose on society, as a whole, in terms of health care (Tarricone, 2006). Cost of illness models are based on epidemiological evidence in which exposure to certain health risk factors (in this case physical inactivity) are used to determine the relative risk (RR) of disease (Stephenson, Bauman, & Armstrong, 2000). For example, how much physical inactivity 'contributes' to cardiovascular disease. Relative risk, together with the prevalence of the risk factor in the population, is then used to determine population attributable risk (PAR). Population attributable risk represents the amount of morbidity and/or mortality attributable to a health risk factor in the population, and that which might be prevented if the population reduced or eliminated this risk factor. Population attributable risk can then be extrapolated to estimate the health care expenditure associated with this health risk factor.

Physical inactivity based COI studies by Russell, Jensen, Sullivan, Wilson, & Berkeley (1993) and Bauman (1997) suggested that a 5% increase in levels of PA in New Zealander adults could result in savings of NZ$25million through reduced health expenditure, additional years of life and decreased incapacity. This could increase to NZ$55million if PA were to be increased 10% and to NZ$160million if all New Zealanders were physically active. A more recent New Zealand study by Tobias & Roberts (2001) also suggests that both improving the uptake of PA (i.e. moving people from inactive to active) and reducing physical inactivity relapse (i.e. reducing people moving from active to inactive) can have a positive effect on all-cause mortality. Based on a 50% increase in PA uptake in all adults, Tobias & Roberts (2001) estimated there would be a 13.3% reduction in all-cause mortality attributable to physical inactivity. This would equate to 346 fewer deaths per annum in New Zealand. Tobias & Roberts (2001) also estimated that if there was a 33% decrease in relapse rates in all adults i.e. people maintained their PA and did not move from being physically active to inactive, there would be 19.2% reduction in all-cause mortality, resulting in 499 fewer physical inactivity attributable deaths per year.

International COI studies show similar results. For example Katzmarzyk, Gledhill, & Shephard (2000) evaluation estimated that 2.5% (CAD$2.1billion) of total direct health care costs in Canada were attributable to physical inactivity (for the year 1999). Based on seven chronic diseases (coronary artery disease, stroke, hypertension, colon cancer, breast cancer, type 2 diabetes and osteoporosis) Katzmarzyk, Gledhill, & Shephard (2000) estimated that a 10% reduction in physical inactivity in Canadian adults (decrease in prevalence rate from 62% to 56%) could potentially save CAD$150million in direct health care expenditure per annum and avert 21,340 deaths. Stephenson, et al., (2000) performed a similar evaluation in Australia, finding that of the AUS$34.1billion spent on health care expenditure (for 1993-1994) an estimated AUS$377million could be attributed to physical inactivity (based on six conditions being stoke, breast cancer, type 2 diabetes, colon cancer, mental health and coronary heart disease). Stephenson, et al., (2000) estimated that an increase of 5% in the proportion of Australian adults who were sufficiently active (increase in rate from 56% to 61%) could potentially save AUS$36million in health care expenditure. These potential savings increased to AUS$76million with a 10% increase in sufficiently active adults. Stephenson, et al., (2000) also indicated that for every 1% increase in the proportion of adults who were sufficiently active 122 deaths could be averted and AUS$3.6million in health expenditure saved from coronary heart disease, type 2 diabetes and colon cancer alone.

2.5.3 Economic benefits of physically active older adults

The burden and cost of physical inactivity can also be found in research that has measured the economic effects of PA. Evidence from these studies indicates that PA can impact on health care service utilisation and health expenditure, as well as provide cost effective health interventions. For example Hagberg & Lindholm (2006) review of 26 international physical activity interventions, each of which had undergone an economic evaluation, found varying economic benefits. These benefits included treatment effects (i.e. improved health or quality of life), preventative effects (i.e. decreased risk of future poor health) and health effect (i.e. gained years of life or quality adjusted life years). Savings in healthcare were gained from, for example, reductions in falls, hip fractures, drug utilisation and hospitalisation, as well as from reduced risks of mortality, improved quality of life and improved health profiles (e.g.,

improved cholesterol and blood pressure). In addition 18 of the 26 studies were shown to be cost effective, that is the benefits from the programs treatment, prevention and/or health effects were greater than the program costs.

Economic benefits have also been found in relation to older adults, with PA being shown to effect health care service utilisation and health care expenditure. Research by Wang, et al., (2005) into retirees' utilisation of outpatient, emergency room and hospital health care services found significant differences in utilisation based on level of PA, irrespective of BMI classification. Likewise Wang, et al., (2005) found there was a 1.26 to 1.63 times increase in sedentary retirees' outpatient claims, compared to moderately active retirees', and a 0.55 to 1.69 times increase in moderately active retirees' outpatient claims compared to very active retirees'. Sari (2009) also found that inactive older adults had 5.5% more GP visits, 12% more nurse visits and 13% more medical specialist visits than active older adults. Similarly, in respect to health expenditure, Ackermann, et al., (2008) found that older adults who attended one or more EnhanceFitness session per week had, compared to those who did not attend, a reduction in health care expenditure of US$1,929 and US$1,784 in years one and two respectively. The EnhanceFitness programme consisted of a 20 minute aerobic workout, 20 minutes of strength training and 10 minutes of stretching, with balance exercises incorporated throughout the session. Andreyeva & Sturm (2006) also found a 7% reduction in health care expenditure (over a two year period) between active and inactive individuals aged 54 to 69 years, while Brown, Hockey, & Dobson (2008) found costs were 26% higher in sedentary women compared to moderately active women. Likewise Yang, et al., (2011), study on the impact of PA on medical care costs amongst Japanese elderly found that per capita medical care costs were $US827.30, US$711.10 and $US702.00 per month for older adults who were classified as performing low, average or high levels of PA respectively.

Economic evaluations indicate, in addition to reductions in health care service utilisation and savings in health care expenditure, that older adult PA programmes can also be 'cost' effective. For example Ackermann, et al., (2003) found in retrospectively matched cohorts (aged 65+ years) that annual increases in health care costs were US$533 lower in programme participants than in the non-participating control group. Hospitalisation rates also reduced by 4.9% in programme participants compared to the control group. Furthermore

savings in health care were found to be 5.7 times more than the cost of providing the programme. Similar results were found by Leveille, et al., (1998) for chronically ill adults (aged 70+ years) with those that were physically active, compared to those who were not, having a reduction in health care expenditure of US$1,200, a 38% reduction in hospitalisation rates and 72% reduction in hospitalisation days. This equated to health care expenditure savings that were four times the amount of the costs of the programme.

2.6 Conclusion

Older adults have been identified as a population of interest and importance because of three main factors. These are: i) the rapid growth being experienced in this populace (Statistics New Zealand, 2006); ii) their greater prevalence and severity of morbidity and increased mortality (Fletcher & Lynn, 2002; Ministry of Health, 2006), and iii) their disproportionately large percentage of health care utilisation and expenditure (Bryant, et al., 2004).

Based on an array of epidemiological evidence, PA has been identified as a valuable and versatile primary and secondary prevention health tool for older adults. Benefits identified included physiological changes that reduce the effects of the aging process (Fiatarone Singh, 2002) as well as the risks and symptoms of many health conditions and diseases (Carr, 2001). Physically active older adults were shown to have reductions in all-cause mortality (Paffenbarger Jr, et al., 1986); increased life expectancy (Ferrucci, et al., 1999) and reduced disability (Leveille, Guralnik, Ferrucci, & Langlois, 1999).

Encouraging older adults to be physically active was also supported by evidence that highlighted the relationship between older adult health, health care service utilisation and health expenditure. This evidence indicated that maintaining or improving older adult health and compressing ‘time to death’ was a valid and legitimate means in which to improve older adult quality of life and reduce health expenditure (Lubitz, et al., 2003; Z. Yang, et al., 2003). Evidence from various studies also showed the positive economic benefits associated with older adult being physically active, including reductions in health care utilisation (Wang, et al., 2005) and reductions in health care expenditure (Ackermann, et al., 2008; G. Yang, et al., 2011). The ‘cost’ effectiveness of older adult PA programmes was also demonstrated (Ackermann, et al., 2003; Leveille, et al., 1998). These findings therefore suggest that PA is important for

older adults to maintain or improve their health and wellness and that older adult PA can have many physiological, psychosocial and economic benefits.

Chapter 3: Methodology

3.1 Introduction

This study was based on deductive reasoning founded in the etiological rationale that changes in exposure to certain health risk factors, namely PA, affect health status and disease incidence, and as a consequence health care service utilisation and health expenditure. This reasoning was derived from epidemiological evidence which demonstrates the many health benefits associated with engaging in PA and/or exercise (Blair, et al., 1995; Hu, et al., 2004; Myers, et al., 2004; Oguma, et al., 2002; Paffenbarger Jr, et al., 1986).

Ideally this etiological rational would be best tested using a randomised controlled trial, whereby study participants would be randomly selected and assigned to either an experimental or control group. Those in the experimental group would then receive the intervention (e.g., the Never 2 Old Active Aging programme (N2O)) and those in the control group would not. The researcher would then look for changes in the dependent variables (e.g., health status, falls, and health care service utilisation) brought about by altering the independent variable (e.g., participation in the N2O) by comparing the pre and post-test results of each group. If pre and post-test results of the experimental group were statistically different, relative to results found in the control group, this would indicate a causal relationship between programme participation and dependent variables.

While randomised controlled trials are considered the 'gold standard', this methodological approach was not considered feasible for this study. This was primarily due to the status of the N2O, which having been active since 2002, meant there was no opportunity for the researcher to pre-test N2O members or (if feasible) to establish an appropriate control group. While several alternative baseline data sources were identified these were rejected on investigation by the researcher. These alternative data sources included:

- Administrative records of N2O providers. While these records contained the results of standardised 'performance' tests of N2O members e.g., sit to stand and timed up and go) these data did not include the breadth of measures relevant to this study. Data were limited to only physical changes (e.g., endurance or strength) and did not include 'health'

measures (e.g., health status). Furthermore data were incomplete and inconsistent as it was collected on a voluntary basis (both from N2O members and by N2O providers) and did not necessarily coincide with N2O members' commencement of the programme.

- Medical/health insurance records. While medical records had the potential to provide baseline data, data were limited to health expenditure. In addition given that not all N2O members had medical insurance the data would be incomplete. There was also concern that response rates would be negatively affected if members were required to provide consent to access personal medical /health insurance records.
- N2O members' completion of a second questionnaire about prior health. While there was concern that a second questionnaire would increase respondent burden and affect response rates, the main concern was the increased likelihood that the data would be inaccurate and/or incomplete given the longer recall period (i.e. some N2O members had been members for eight years, making it highly unlikely that they would be able to recall or have records pertaining to their health status prior to joining the programme).

In addition to the active status of the N2O, time constraints of this thesis also meant it was unlikely that the use of a randomised controlled trial would enable a sufficiently large sample of new N2O members to be amassed (and be pre and post-tested). The use of a randomised controlled trial would also mean that recruitment of participants would be staggered. The use of staggered recruitment would also make it more difficult to assess N2O effects given many PA health benefits can take some time to 'develop' and therefore may not have become evident within the shortened participation period.

3.2 Never 2 Old Active Aging Programme

The N2O, developed by Auckland University of Technology in 2002, is a PA programme designed specifically for older New Zealand adults. While the N2O primarily focuses on resistance exercise it also includes balance, flexibility, gait and cardiovascular activities. The N2O consists of a series of progressive programmes in which N2O members are provided with a series of 'guided' exercises. These programmes move N2O members through 'basic' preparatory

exercises to more advanced exercises (refer Appendix 1 and 2 for example programmes). While the 'beginner' N2O programmes are designed to build confidence and some overall anaerobic and aerobic conditioning (i.e. muscular strength, power and endurance), latter N2O programmes focus more on improving stability and performance in functional tasks such as walking up and down stairs, lifting, reaching and sit-to-stand. The N2O also promotes a more holistic approach to older adults' fitness, health and wellbeing by providing educational seminars, YAHOO challenges (Young at Heart Outdoor Opportunities), special events (e.g., modified sports and inter 'club' challenges) and social functions.

It should be noted that while the basic principles of the N2O are applied N2O provider do, to some extent, 'customise' the N2O to suit their individual facilities and the needs of their N2O members.

3.3 Design and Method

3.3.1 Design

While the design of this study was based on epidemiological evidence linking PA and health, methodology was influenced by the active status of the N2O and time constraints of the thesis. As a consequence it was not considered feasible for this study to use the 'gold standard' method of a randomised controlled trial, using instead a retrospective non-experimental observational approach.

In choosing a non-experimental observational approach two fundamental issues were identified for this study. The first was that the study lacked a control group, and the second was that there was no baseline or pre-intervention data for N2O members. Because of this it was not possible to directly compare those who received the intervention (i.e. N2O) to those who did not, nor evaluate changes in outcomes of N2O members prior to and after participation in the programme. Hence calculating changes in key outcomes could not be done directly. Consequently identification and measurement of the effects of participation in the N2O on the outcomes of interest, and establishing causal relationships, was difficult.

Given these limitations several strategies were identified and employed in order to add persuasive and credible evidence to this study. The first strategy

was to establish a ‘pseudo’ control group or benchmark to which the results of this study could be compared, and for which inferences about the impact of the N2O could be made. This approach was used by Wilson & Datta (2001) in their cost-benefit analysis of Tai Chi programmes. In the Wilson & Datta (2001) study, literature based estimates (i.e. national statistics and information on costs, usage, frequency etc. generated through governmental and private research) were used to develop a comparison or control for their intervention group. For the present study, the Ministry of Health’s 2006/2007 National Health Survey (MoH) (Ministry of Health, 2008) was identified as a suitable comparison.

The second strategy used was to subdivide N2O members into subgroups based on differentiated levels of engagement in the N2O. This subgroup analysis was used to enable N2O effects to be isolated and assessed and was based on the assumption that health effects of the N2O would be related to volume (i.e. cumulative hours of engagement in the N2O).

This study was approved by the Auckland University of Technology Ethics Committee (Reference number 10/158).

3.3.2 Sample

The population of interest for this study were older adults (aged 60+ years) who were potential participants of the N2O. Recruitment consisted of a two-step process involving firstly N2O providers and secondly their respective N2O members. No randomisation process was involved in either the recruitment or selection of the sample which was one of convenience, based on self-selected volunteers.

A non-randomised approach was chosen for this study because of the small number of N2O providers (n=16), and an inability to obtain a complete and accurate sampling frame of N2O members through N2O provider membership lists. In using a non-probability sampling approach with self-selected volunteers, the researcher acknowledged the potential increase for bias (e.g., sampling and volunteer) and non-representativeness of the sample.

N2O providers

Selection procedure:

A list of N2O providers (as at December 2010) was obtained from the N2O franchise holder, Auckland University of Technology. A total of sixteen providers, including the Auckland University of Technology, were identified. No randomised selection process was performed with all sixteen providers included for selection.

Recruitment took place over a six month period (January to June 2011), during which time four invitations were sent (January, February, March and May 2011). Invitations consisted of a brief introductory letter, together with the N2O provider information sheet, consent form and questionnaire. Invitations were sent by email and post, followed-up by phone (maximum of four contacts). It was assumed that N2O providers that had not responded during the six month recruitment period were not interested in participating in the study (refer Appendix 3 and 5 for N2O provider information sheet and questionnaire).

N2O members

Selection procedure:

No randomised selection process was used, with all N2O members being included for selection. Recruitment occurred in two waves over a four month period (February/March and June/July 2011). The first recruitment wave was by way of a single brief group presentation (five minutes maximum) at each consenting N2O provider centre. Presentation times and days, while requested to be the 'busiest', were set by each N2O provider. N2O members that expressed an interest in participating in the study at the end of these presentations were provided with a N2O members pack. N2O member packs contained the N2O members' information sheet, consent form, questionnaire and prepaid return envelope. Additional N2O members' packs were left at each N2O provider centre for N2O members not present on the day. A total of 500 packs were distributed.

Secondary recruitment was by way of a single mail out, approximately two months after the last presentation (late June 2011). The mail out was limited to i) N2O members of N2O providers who supplied membership lists (n=4), and ii) N2O members for which no consent form had been received. A

total of 360 mail invitations were sent, each containing a brief introductory letter and the N2O members pack. It was assumed that N2O members who had not responded by the mail out cut-off date (being 18th July 2011) were not interested in participating in the study (refer Appendix 4 and 6 for N2O members information sheet and questionnaire).

3.3.3 Measures

Self-administered hardcopy questionnaires were chosen for this study as they offered not only an easy and cost-effective means of distribution, but also privacy, convenience and flexibility for respondents. Given the low response rates often associated with questionnaires (Edwards, et al., 2002), reducing respondent burden and resistance was of particular importance to this study. Edwards, et al., (2002) suggest response rates are influenced by factors such as incentives, length of questionnaires, personalisation, visual aspects (e.g., colour), stamped return envelopes, prior contact, follow up, topic (i.e. of interest or sensitive nature) and source (i.e. university or commercial). In an attempt to enhance response rates in this study invitations were 'personalised' (i.e. face to face presentations, personalised letters, phone contact) and included a self-addressed return envelope. The questionnaires were also allowed to be taken home. Furthermore the questionnaire was drawn from well-tested and proven questions/questionnaires, and used only questions relevant to the study and which could be answered fairly quickly and easily.

N2O provider questionnaire

No existing questionnaires were identified for the collection of data from N2O providers. The N2O provider questionnaire was based on health economic evaluation guidelines developed by Drummond, et al., (2005), and from information identified by the researcher as part of the literature review. The N2O providers' questionnaire consisted of six questions pertaining to the N2O including membership, delivery period, session frequency and costs. Only N2O providers with level one consent completed the financial portion of the questionnaire. The N2O provider questionnaire was neither validated nor tested for reliability, however the information sought was that which would typically be produced by any business or organisation (refer Appendix 5, N2O provider questionnaire).

N2O members' questionnaires

The N2O members' questionnaire was based on the Ministry of Health 2006/2007 New Zealand Health Survey (MoH), a national survey undertaken every four years. The MoH survey provides a self-reported measure of physical and mental health status, health behaviours and health care service utilisation. It includes both the New Zealand Physical Activity Short Form Questionnaire (NZPAQ-SF) and Medical Outcomes Short Form Questionnaire (SF-36).

The MoH survey was modified to accommodate the requirements of the present study. These modifications included removing non-relevant questions and adding study specific questions (based on health economic evaluation guidelines developed by Drummond, et al., 2005). The modified questionnaire (refer N2O participants questionnaire Appendix 6) consisted of 39 structured questions in which N2O members were asked about their PA, health status, health conditions, health care service utilisation, health expenditure, falls and involvement in the N2O. To ensure anonymity no information which could identify individual participants was collected on the N2O members' questionnaire. All questionnaires were completed at home with responses posted back in the prepaid envelope provided.

New Zealand Physical Activity Short Form Questionnaire (NZPAQ-SF):

The NZPAQ-SF is a culturally modified version of the International Physical Activity Short Form Questionnaire (IPAQ-SF), a questionnaire often used as a standardised measure to estimate PA. The IPAQ-SF has been used in a variety of populations and socio-cultural contexts and has been identified as a valid and reliable measurement tool in twelve countries (Craig, et al., 2003). The NZPAQ-SF has been shown to be comparable to the IPAQ-SF (Maddison, et al., 2007). Like the IPAQ-SF the NZPAQ-SF is a self-assessed measurement tool, designed to be administered face to face, in which three dimensions of PA (frequency, duration and intensity) are assessed. The NZPAQ-SF does not measure PA context (i.e. purpose or circumstances) or mode (i.e. type).

Medical Outcomes Short Form Questionnaire (SF-36):

The SF-36 is a generic multi-purpose measure (i.e. does not target age, disease or treatment) consisting of 36 questions that provides an eight scale

profile of functional and psychometrical health and well-being. The eight scales can also be 'combined' to produce summary scores that represent all aspects of physical and/or mental health. Each of the eight scale items produce scores that range between 1 and 100, with greater scores indicating better self-reported health. The eight scale items are:

- *Physical functioning* describes mobility and agility limitations, and limitations in self-care (SFpf).
- *Role physical* describes limitations in role fulfilment because of physical health problems (SFrp).
- *Bodily pain* describes the intensity of and interference with everyday activities caused by bodily pain (SFbp).
- *General health* is a self-rating of one's overall health (SFgh).
- *Vitality* describes one's energy levels (SFv).
- *Social functioning* describes the extent to which health problems interfere with social activities (SFsf).
- *Role emotional* describes limitations in role fulfilment because of mental health problems (SFre).
- *Mental health* describes one's levels of anxiety and depression (SFmh).

The SF-36 has been used with general and specific populations to study more than 200 diseases and conditions (Turner-Bowker, Bartley, & Ware Jr, 2002; Ware, Kosinski, & Keller, 1994; Ware, Snow, Kosinski, & Gandek, 1993). Because of the widespread use of the SF-36 there is extensive evidence as to the questionnaires content, concurrent, criterion, construct, and predictive validity (Ware, Kosinski, & Keller, 1994; Ware, Snow, Kosinski, & Gandek, 1993).

3.3.4 Data

Physical activity

National data comparison – MoH 2006/2007 New Zealand Health Survey:

Physical activity comparisons to the MoH pseudo control group were based on the two PA classifications used by the MoH, being:

- *Regularly physically active (RPA).* Defined by the MoH as 30 minutes (or more) of PA per day on five or more days per week;
- *Sedentary.* Defined by the MoH as having engaged in less than 30 minutes of PA in the last week.

In addition to the MoH pseudo control group comparisons, difference-in-differences were also calculated. Difference-in-differences analysis is a quasi-experimental technique used in economics and other disciplines to measure the change induced by a particular 'intervention' (in this case the N2O programme). Difference-in-differences analysis is used to isolate the effects of the intervention from other factors that may also impact on outcome measures. For example the effect of a nationwide falls campaign could also have an effect on falls in older adults. In using difference-in-differences analysis the effect of the intervention is isolated by comparing the differences between the pre-post within subject differences of the intervention group and to those of the control group. Difference-in-differences analysis uses the control group (in this case the MoH) to subtract out 'other changes' (e.g., the effects of a nationwide falls campaign), that may have occurred during the intervention period. This 'subtraction' is based on the assumption that the effect of these 'other changes' were identical in both the intervention and control group, and that the composition of the two groups remains the same over the course of the intervention.

While no pre-post test data were available for this study, difference-in-differences analysis has been used to identify the effects of participation in the N2O across the three age groups. Age group differences were identified as an area of interest given the evidence which indicates that PA decreases and sedentary behaviour increases exponentially with advancing age. For this study the MoH has been treated as the control group. Hence it has been assumed that changes found in the MoH were changes that might be expected to be found in the general population with age. Hence by subtracting the 'normal' change in PA or sedentary behaviour that would be expected with age (as identified by the MoH) from those changes found in the N2O group, the effect of the N2O programme can be isolated.

The formulae used to calculate difference-in-differences between successive age groups of N2O and MoH was $(N2O_n – N2O_{n-1}) – (MoH_n – MoH_{n-}$

$_1$). The first term is the change in the PA outcome between successive N2O age groups, which is benchmarked against the change in PA outcomes in successive age groups of the MoH (the second term).

N2O intra group comparison:

N2O members' subgroup comparisons were based on dose response score, which were calculated by multiplying N2O members' period of membership (in months) by the average number of monthly sessions attended. Given the typical N2O session was an hour, the dose response score in effect expressed hours of engagement in the N2O i.e. programme volume.

Dose response scores were grouped into three categories for analysis being:

- high dose (>= 301 sessions or hours)
- medium dose (>=101 and <=300 sessions or hours)
- low dose (<=100 sessions or hours)

No guidelines or recommendations were identified to assist in the establishment of these dose response categories and were therefore arbitrarily set at the discretion of the researcher. The categories were based on the researchers' knowledge and understanding of PA and the N2O. Factors taken into consideration included i) the PA guidelines which were estimated to equate to between 130hrs and 182hrs per year (30min x 5 days x 52 weeks; 30min x 7 days x 52 weeks), and ii) statistical information specific to the N2O members in this study, i.e. the score range (from three to 1152hrs), mean 244.36hrs (SD 226.83hrs) and median 192hrs.

SF-36 Self-rated health status

As with PA difference-in-differences between successive age groups were used in the analysis of SF-36 self-rated health data. Age group differences were identified as an area of interest given evidence which indicates self-assessed health status decreases significantly with an increase in age.

Health care service utilisation and expenditure

Health services were divided into categories based on those used by the MoH (Ministry of Health, 2004). These were:

- General Practitioners (GP): This included services from medical doctors who practices 'general' medicine and attended to the everyday medical needs of individuals within a community.
- Complementary/alternative health care: This included services such as massage, homeopath or naturopath, acupuncture, traditional Chinese medicine practitioner, Maori or Pacific traditional healer.
- Medical specialist: This included general physicians, cardiologists, dermatologists, gynaecologist, neurologist, ear/nose/throat surgeon, rheumatologist, ophthalmologist (which can be seen in a public or private hospital).
- Hospital: This included any institution that provided medical, surgical, or psychiatric care or treatment for the sick and injured. These services could be provided by both public and private institutes.

Note other primary health care services such as physiotherapist, chiropractors, occupational therapists, osteopath, dieticians and opticians/ optometrists were not included in the evaluation due to the lack of MoH comparative data.

N2O costs and economic assessment

N2O costs:

N2O cost data were reported for the financials periods between January 2009 and December 2010.

Average sessions costs were calculated using the total number of sessions provided per annum by the seven N2O providers who supplied cost data. This was calculated for a 49 week period as typically the N2O was not provided over the Christmas and New Year period. Hence total annual N2O sessions for these seven N2O providers were 980 (20 weekly N2O sessions for the seven participating N2O providers times 49 weeks) (refer Table 28).

Given information on N2O member numbers was not available, average N2O member costs were calculated based on estimated attendance rates. This calculation was based on a single N2O provider that was able to provide session attendance rates. This N2O provider (provider F per Table 28) indicated that on average 28 N2O members attended each of their sessions. For analysis purposes it was assumed that each N2O provider's average session cost was reflective of their attendance rates i.e. the greater the N2O providers' average session cost the greater the attendance rate. The average N2O member cost was calculated as the average N2O provider session cost divided by average N2O member attendance. The average N2O member cost was then used to calculate the average annual cost per N2O member. This was based on an average of eight monthly sessions (2 sessions per week) over a 49 week period (total of 98 sessions attended per year, being 2 sessions per week for 49 weeks).

Economic assessment:

A preliminary economic assessment as to the effects of the N2O was performed based on a Cost of Illness model. Figures used in the calculation were based on values described below.

1) Population attributable risk (PAR) formulae:

$$\frac{\text{Prevalence of population health risk factor} * (\text{Relative Risk} - 1)}{1 + \text{Prevalence of population health risk factor} * (\text{Relative Risk} - 1)}$$

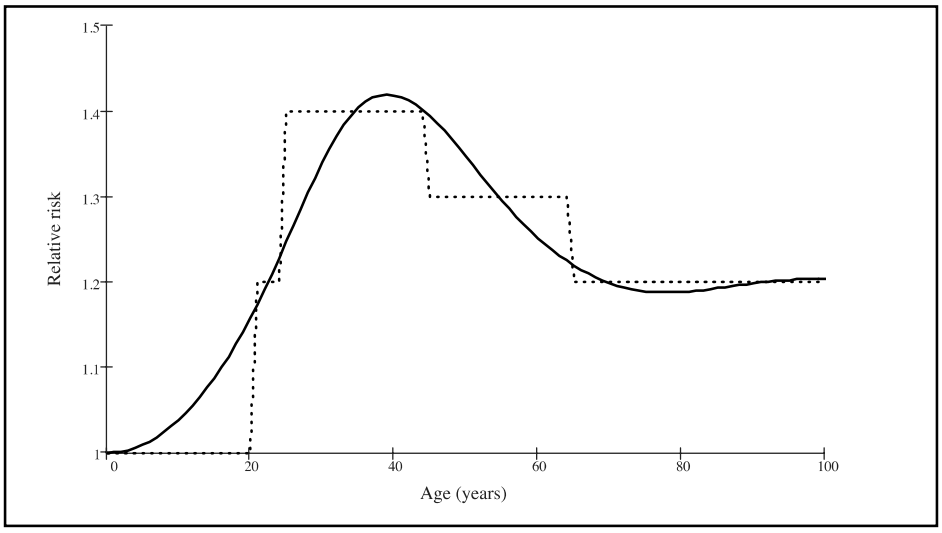
2) Prevalence of health risk factor – Sedentary: This value was based on the total rate of sedentary behaviour in older adults, as identified by the MoH, being 16.90% (Ministry of Health, 2008). For the prevalence of physically inactive the value was based on the total rate of MoH older adults who did not meet RPA classification. The overall percentage of MoH older adults classified as RPA was calculated as 46.88% therefore 53.12% were classified as physically inactive.

3) Relative Risk (RR): RR values for physical inactivity (i.e. the contribution physical inactivity makes to disease/ill health) were based on Tobias &

Roberts (2001) study which used an all-cause mortality measure (as opposed to specific health conditions). Given Tobias & Roberts (2001) RR values were age dependent, ranging between 1.2 and 1.3 for those aged 60+yrs (refer Figure 5), this study used an RR value of 1.25 to represent all older adults. This RR indicates that 'exposure' to physical inactivity increases the probability of mortality by 25% for those aged 60+yrs.

4) Population: This was based on the estimated population for 2010, being 4,362,000, of which approximately 12.9% were older adults (equating to approximately 564,500 (Statistics New Zealand, 2011).

Figure 5: Relative Risk of mortality conditional on physical inactivity.



(Tobias, 2001, pg. 143)

5) Mortality: Based on provisional 2010 data older New Zealand adults (aged 60+yrs) deaths were estimated to be 23,766 (Ministry of Health, 2011). The percentage of these deaths attributed to physical inactivity were 1,901, being 8%, which was identified by the Ministry of Health (Ministry of Health, 2003a) as the percentage of all deaths per year in New Zealand associated with physical inactivity.

6) Health expenditure: Based on 2010 governmental figures health expenditure was estimated to be NZ$13,128 million (The Treasury, 2011) Of this an estimated 40% is spent on older adults (Fletcher & Lynn,

2002) equating to approx. NZ$5,251.2million. The amount attributable to physical inactivity was estimated to be NZ$105.024million. This represented 2% of older adult health expenditure. This was based Oldrigde (2008) review of international physical inactivity cost of illness studies which indicated between 1.5% and 2.5% of direct health expenditure could be attributed to physical inactivity.

Data analysis

N2O member questionnaire data were subject to statistical analysis using Microsoft Office Excel 2007 and SAS (version 9.2) to provide frequency response statistics. Mean values and standard deviations were used throughout as indicators of the centrality and spread of the data. Responses that included qualitative “comments” (question 29, N2O members questionnaire) were manually coded and grouped into main themes to facilitate analysis and interpretation.

For evaluation purposes, the effects of the independent variable, being participation in the N2O, were assessed based on dose response score (i.e. volume), and its two variables period of membership and average monthly sessions attended. The dependent variables evaluated included PA, health status, health care service utilisation, health expenditure and falls.

Comparative information from the MoH pseudo control group was available for PA, health status and health care service utilisation. N2O members’ sub-group comparisons were performed for all dependent variables.

Differences between groups were tested for statistical significance using 95% confidence intervals that incorporated the estimated sample errors from respective samples. Use of the 95% confidence intervals meant that there was a 95% probability that the estimated interval included the population parameter. Differences between estimates were said to be statistically significant if the 95% confidence intervals of each measure did not overlap. Linear regression analysis using STATA (version 10) was used to test the extent to which dependent health variables could be predicted by participation in the N2O programme (included dose response scores, period of membership and average monthly session attendance). Probit regression analysis was also used to report the estimated partial derivatives of the dependent variables (e.g., the change in the probability of PA classification) given a one unit change in the

explanatory variable (e.g., dose response score), holding the other explanatory variables constant. The level of statistical significance was set at $p<0.05$.

3.4 Validity and reliability

External validity refers to the extent that results found in one study can be generalised, transferred or applied to other populations and 'settings'. One of the key determinants of external validity lays with sample selection and recruitment, hence study design and methodology has several implications for external validity.

For this study the small number of N2O providers, together with an inability to obtain a complete and accurate sampling frame of N2O members (i.e. the absence of membership lists), meant that it was not feasible to use a randomised sample selection process. Studies that use non-probability sampling and self-selected samples often increase the probability of selection and volunteer bias and therefore the likelihood that the sample will not be representative of the population. For example, individuals with better pre-existing health status and lower health expenditures may have been more likely to participate in both the N2O and this study.

Similarly study characteristics such as place or time e.g., this study's geographic confinement to the Auckland metropolitan area, and the use of a single one off measurement, also have implications for generalisation, as does the nature and characteristics of the study and its participants (i.e., the heterogeneity associated with older adults and the complex nature of PA).

The use of a non-experimental approach also has implications for establishing cause and effect as the direction of cause is uncertain (i.e. does level of PA affect health status or does health status, for example poor health, affect PA engagement). This is further complicated by other variables that affect 'health' e.g., diet, PA history etc., which were outside the scope of this study.

While MoH comparative data has been used in an attempt to address some of these concerns, MoH comparatives themselves have limitations and 'unknowns'. Such unknowns include the type of PA MoH respondents engaged in and what effect level of PA had on the other variables (e.g., health status and health care service utilisation). Such unknowns increase the chance that the two groups are not probabilistically equivalent for comparative purposes.

The use of self-assessed retrospective questionnaires also raises

concerns about measurement error (e.g., reliance on memory/recall and hence recall bias, or self-assessed values that are significantly different from the actual values of the attribute being measured). This is particularly relevant to PA where it is suggested that overestimation is 'inherent' in self-reports particularly amongst less active individuals and older people (Van Sluijs, Griffin, & Van Poppel, 2007).

While these limitations are acknowledged, this study does enable a 'gradient of similarity' to be developed (i.e. relative similarity of participants and programmes, given the 'alikeness' of certain characteristic, context and conditions, and therefore comparative generalisation). This is particularly relevant to 'real world contexts' because of this study's use of a real world setting, the N2O programme, as opposed to an 'artificial' clinical trial.

3.5 Summary

This study was based on an etiological rationale derived from a wealth of epidemiological evidence which shows the many health benefits associated with engaging in PA and exercise (Blair, et al., 1995; Hu, et al., 2004; Myers, et al., 2004; Oguma, et al., 2002; Paffenbarger Jr, et al., 1986).

While the ideal methodology for testing this rationale would be a randomised controlled trail, this approach was not feasible for this study given the active status of the N2O and time constraints of the thesis itself. Given these limitations a retrospective non-experimental observational approach was chosen.

In choosing a non-experimental approach two major limitations were identified, being the lack of a control group and lack of baseline data for N2O members. To address these limitations, a pseudo control group was established (being the MoH 2006/2007 National Health Survey) together with N2O members sub-grouped (based on volume) to provide comparative data. While it was unlikely that these alternative comparatives approaches would be as rigorous as performing a randomised controlled trial, they were, given the limitations of this study, a means in which to isolate and assess the true effects of the N2O and add persuasive and credible evidence to this study.

Chapter 4: Results

4.1 Introduction

The aim of this study was to investigate whether participation in the N2O programme had any effect on PA, health status, health care service utilisation, health expenditure and falls, and if so how these might be translated into economic measures.

In preparing these results the researcher acknowledges and highlights two evaluation considerations. Firstly, while PA was identified as a study outcome, the nature of the N2O, being a PA programme, inevitably means PA was 'created' as a by-product of participation in the N2O. The second consideration was that only fifteen N2O members were included in the 55-64yrs age group (three male and twelve female). The small sample size in this age group increases the probability of sampling error and likelihood that the sample was not representative of the population from which it was drawn. Hence while analysis has included those aged 55-64yrs, the focus for this study has been on those aged 65-74yrs and 75+yrs where samples were of sufficient size.

The results chapter has been divided into nine sections. The first section provides summary information about the study participants, both N2O providers and N2O members. Section two provides a brief overview of health conditions, a variable considered to be of interest to this study. The third section looks at the dependent variable PA. The analysis of PA has been based on the two MoH PA classifications (regularly physically active and sedentary) and the three N2O member sub-groups. Sections four to seven look at the other dependent variables, being health status, health care service utilisation, health expenditure and falls. However comparative MoH information was only available for health status and health care service utilisation. The eighth section looks at the qualitative aspects of the N2O as identified by N2O members, while section nine provides a financial overview and preliminary economic assessment of the N2O using a cost of illness model.

For analysis purposes differences between point estimates were identified as statistically significant when the 95% confidence intervals for comparative measures did not overlap. Linear regression analysis was also used to test the extent to which the dependent variables could be predicted by

N2O programme engagement. Probit regression analysis was used to report the estimated partial derivatives of the dependent variables given a one-unit change in the independent variable. The level of statistical significance was set at $p<0.05$.

4.2 Sample

4.2.1 N2O providers

Sample description:

Of the sixteen N2O providers invited, eleven consented, three declined and two did not respond. Reasons for decline included a lack of time (n=1), change in staff (n=1), and the N2O having not commenced (n=1). The final response rate for N2O providers was 68.75%.

Of the three levels of participation offered four N2O providers agreed to level one, five to level two, and two to level three. Those who consented to level one agree to take part in the research fully (i.e., providing N2O related financial data, administrative information and access to N2O members). Those who consented to level two agreed to partial participation (i.e. administrative information and access to N2O members), while level three consent was for access to N2O members only. N2O providers' level of participation was a key component in the economic evaluation of the N2O as only those who consented to level one agreed to supply N2O programme financial data.

Consenting N2O providers:

All N2O providers were located in the Auckland area with consenting N2O providers being dispersed across Central (n=4), North (n=4), South (n=2) and East (n=1) Auckland. Consenting N2O providers had been delivering the N2O for varying periods, being less than one year (n=1), between one and four years (n=9) and more than five years (n=1). Consenting N2O providers offered a minimum of three weekly N2O sessions, with the maximum weekly sessions being seven (one N2O provider only). Preliminary information showed that over half (n=6) of the consenting N2O providers had more than 51 N2O members.

Non-consenting N2O providers:

The five non-consenting N2O providers were located in Auckland Central (n=4) and West (n=1). No additional information was available for these N2O providers.

4.2.2 N2O members

Sample description:

A total of 225 N2O members consented to take part in the study, 116 being obtained through the brief group presentations, and 109 through the mail out. Twenty two mail invitations were returned with a decline, reasons for decline included no longer/not being an active member (n=9), a lack of time (n=2), injury/sickness (n=5), and non-specified (n=6). Eight responses were received subsequent to the cut-off date (ranging between one week and a month later) and were not included in the sample.

Due to a lack of complete and accurate information on membership, determining the number of actual and eligible N2O members was not possible, consequently ascertaining exact N2O member response rates was challenging. Given available information it was estimated that total N2O membership of consenting N2O providers ranged between 349 and 854 N2O members, the large variation being due to disparities in information provided through N2O provider questionnaires and that of the membership lists received. Given these limitations it was estimated that the overall N2O members' response rate was between 26% and 60%. The mail out response rate was 32%.

Consenting N2O members:

Consenting N2O members were aged between 55 and 93 years. It is noted that the population of interest were older adults aged 60+ years, however one participant, being a single female aged 55, was included in the analysis. The average age was 73.8 years, with 58.2% of consenting N2O members being between 65 and 74 years of age. One hundred and forty five (64.4%) of the N2O members were female and 80 (35.6%) male, the majority of which were Caucasian (95.1%), married (56.9%), and retired (86.7%). Consenting N2O members main source of income was superannuation (n=193, 85.8%) with 55.6% having an annual income of between $10,001 and $30,000 (n=125). Health wise 87.5% (n=197) indicated that they had a health condition, the most

common being arthritis (41.3%, n=93), high blood pressure (33.3%, n=75), high cholesterol (28.4%, n=64) and cardiovascular disease (22.2%, n=50). A large percentage of those with health conditions also indicated that these health conditions had been present for ten or more years (e.g., 40.8% arthritis; 36% blood pressure, 23.4% cholesterol, 38% cardiovascular disease). Consenting N2O member characteristics are summarised in Table 10. No N2O member requested that their data be withdrawn from the study.

Non-consenting N2O members:

Of the 22 N2O members that declined the mail invitation, 18 were female (average age 70.33 years) and four male (average age 75.25 years). No information was available for N2O members from the five non-consenting N2O providers.

Table 10: Consenting N2O member demographic information.

	All N2O members	Mean	Percentage	N2O males	Mean	Percentage	N2O females	Mean	Percentage
Number of participants	225			81		36.00%	144		64.00%
Mean age		72.93 (range 55-93)			74.25 (range 62-93)			72.19 (range 55-92)	
age 55-64yrs	15		6.67%	3		3.70%	12		8.33%
age 65-74yrs	129		57.33%	41		50.62%	88		61.11%
age 75+yrs	81		36.00%	37		45.68%	44		30.56%
Ethnicity – Caucasian	214		95.11%	77		95.06%	137		95.14%
Health Conditions:									
Any health condition	197		87.56%	72		88.89%	125		86.81%
Cardiovascular related disease	51		22.67%	31		38.27%	20		13.89%
Diabetes	17		7.56%	11		13.58%	6		4.17%
Osteoporosis	33		14.67%	4		4.94%	29		20.14%
(Osteo)Arthritis	93		41.33%	40		49.38%	53		36.81%
Cancer	24		10.67%	7		8.64%	17		11.81%
High Cholesterol	64		28.44%	21		25.93%	43		29.86%
High Blood pressure	75		33.33%	28		34.57%	47		32.64%
Average number of health conditions:		3 (range 0-9)			3 (range 0-9)			3 (range 0-7)	
SF-36 mean score:									
Total physical health		75.20 (range 30.25-100.00)			72.37 (range 30.25-96.80)			76.81 (range 35.70-100.00)	
Total mental health		80.70 (range 25.00-100.00)			78.45 (range 36.67-100.00)			81.97 (range 25.00-100.00)	
Fallen in past 12 months	43		19.11%	14		17.28%	29		20.14%
Have medical insurance	119		53.13%	41		51.25%	78		54.17%

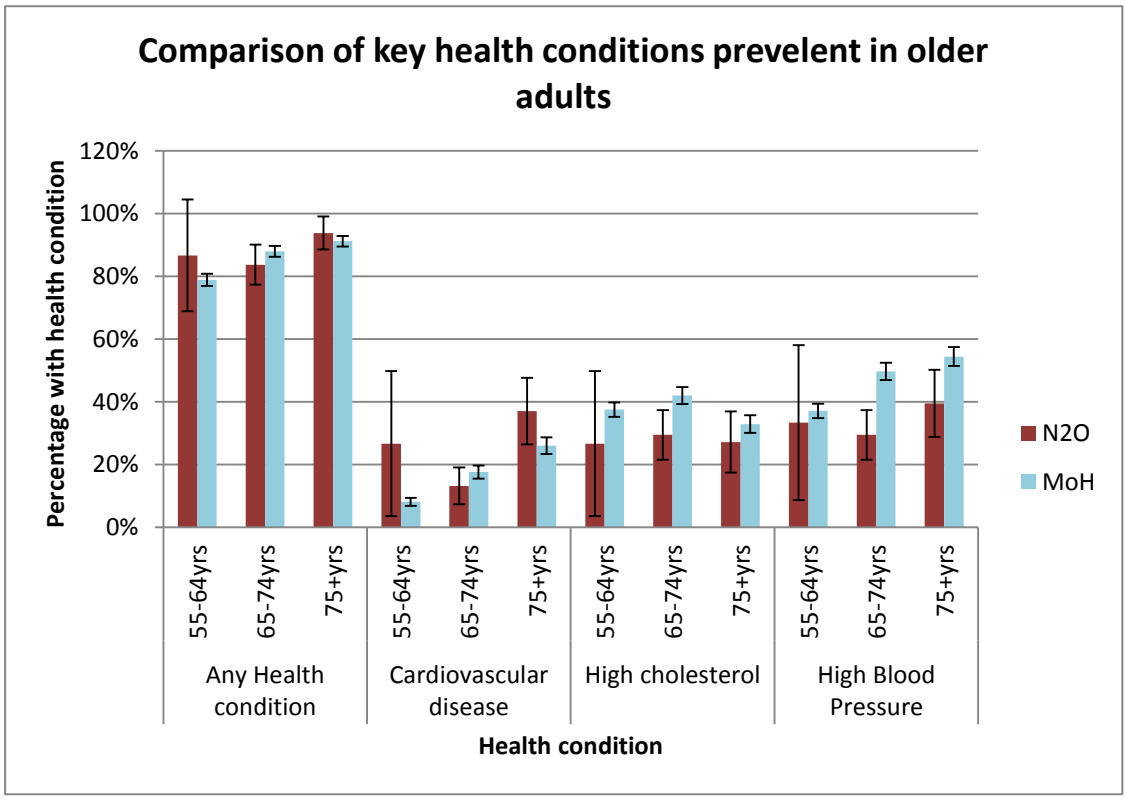
4.3 Variables of interest

4.3.1 Health conditions

As Figure 6 shows, there were no statistically significant differences in the prevalence of any health conditions or cardiovascular disease between the N2O and MOH groups. High cholesterol was found to be less prevalent in all N2O members, with statistically significant differences being found between N2O and MoH aged 65-74yrs. Likewise high blood pressure was less prevalent in N2O than MoH, differences being statistically significant in those aged 65-74yrs and 75+yrs.

Prevalence rates in all four of the health conditions measured were found to be statistically significant between successive MoH age groups. Statistically significant differences between successive N2O age groups were only found in cardiovascular disease between those aged 65-74yrs and 75+yrs (23.86 percentage points).

Figure 6: Comparison of key health condition prevalent in older adults.



Note data are mean ± 2standard deviations
MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

Table 11 shows 87.56% of N2O members had a health condition, of which 66.22% were health conditions which could potentially be modified or influenced by PA (e.g., cardiovascular disease, high cholesterol, high blood pressure, diabetes, and osteoporosis). Of those N2O members with a PA modifiable health condition, 62.67% had the condition prior to joining the N2O.

Table 11: N2O members' health conditions (by age and gender).

	Total percentage of MoH with any health condition	Total percentage of N2O members with any health condition	Percentage of N2O members with a PAHC	Percentage of N2O members with pre-existing PAHC
ALL				
Total	84.98%	87.56%	66.22%	62.67%
55-64yrs	78.90%	86.67%	73.33%	73.33%
65-74yrs	88.00%	83.72%	64.34%	62.79%
75+yrs	91.20%	93.83%	67.90%	60.49%
MALE				
Total	82.88%	88.89%	67.90%	65.43%
55-64yrs	76.60%	100.00%	100.00%	100.00%
65-74yrs	86.00%	87.80%	68.29%	68.29%
75+yrs	89.80%	89.19%	64.86%	59.46%
FEMALE				
Total	86.85%	86.81%	65.28%	61.11%
55-64yrs	81.20%	83.33%	66.67%	66.67%
65-74yrs	89.70%	81.82%	62.50%	60.23%
75+yrs	92.30%	97.73%	70.45%	61.36%

PAHC-PA modifiable health condition
MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

4.4 Dependent Variables

4.4.1 Physical activity

National data comparison – MoH 2006/2007 New Zealand Health Survey:

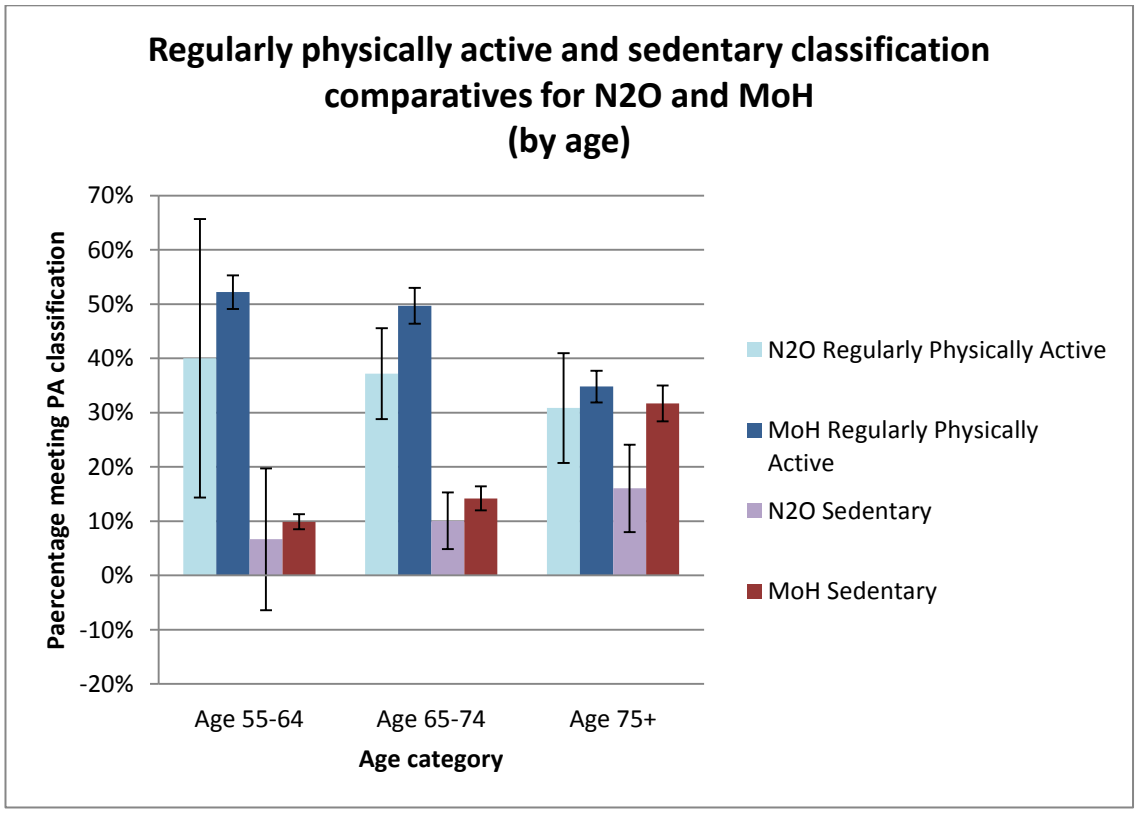
The two PA descriptors used in this section were based on those used by the MoH, being:

- *Regularly physically active (RPA).* Defined by the MoH as 30 minutes (or more) of PA per day on five or more days per week;

- *Sedentary.* Defined by the MoH as having engaged in less than 30 minutes of PA in the last week.

All three MoH age groups tended to have greater percentages classified as regularly physically active (RPA) compared to N2O. However statistically significant differences were only found between N2O and MoH aged 65-74yrs (12.49 percentage points greater for MoH) (refer Figure 7). Consistent with the findings of the MoH, the percentage of N2O members classified as RPA declined with each successive age group. However this age-related tendency to reduce RPA was only statistically significant in MoH between those aged 65-74yrs and 75+yrs (being a decrease of 14.90 percentage points).

Figure 7: Regularly physically active and sedentary classification comparatives for N2O and MoH (by age).

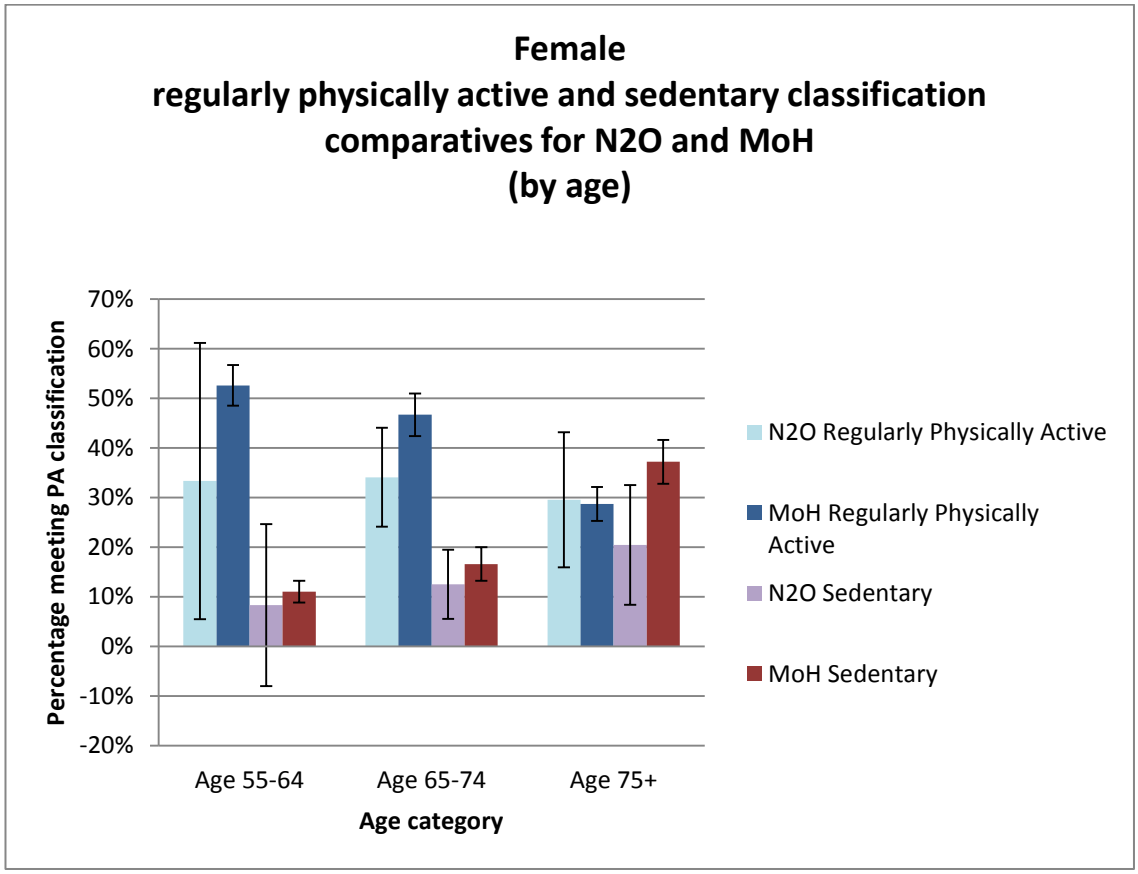


Note data are mean ± 2standard deviations
MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

All three MoH age groups tended to have greater percentages classified as sedentary. However statistically significant differences between N2O and MoH groups were only found in those aged 75+yrs (15.65 percentage points greater in MoH). Like the MoH, N2O members' sedentary behaviour increased

with age, however unlike the MoH changes in successive age groups of N2O were not found to be statistically significant. Between MoH aged 65-74yrs and 75+yrs sedentary classification had a statistically significant increase of 17.50 percentage points.

Figure 8: Regularly physically active and sedentary classification comparatives for females (by age).

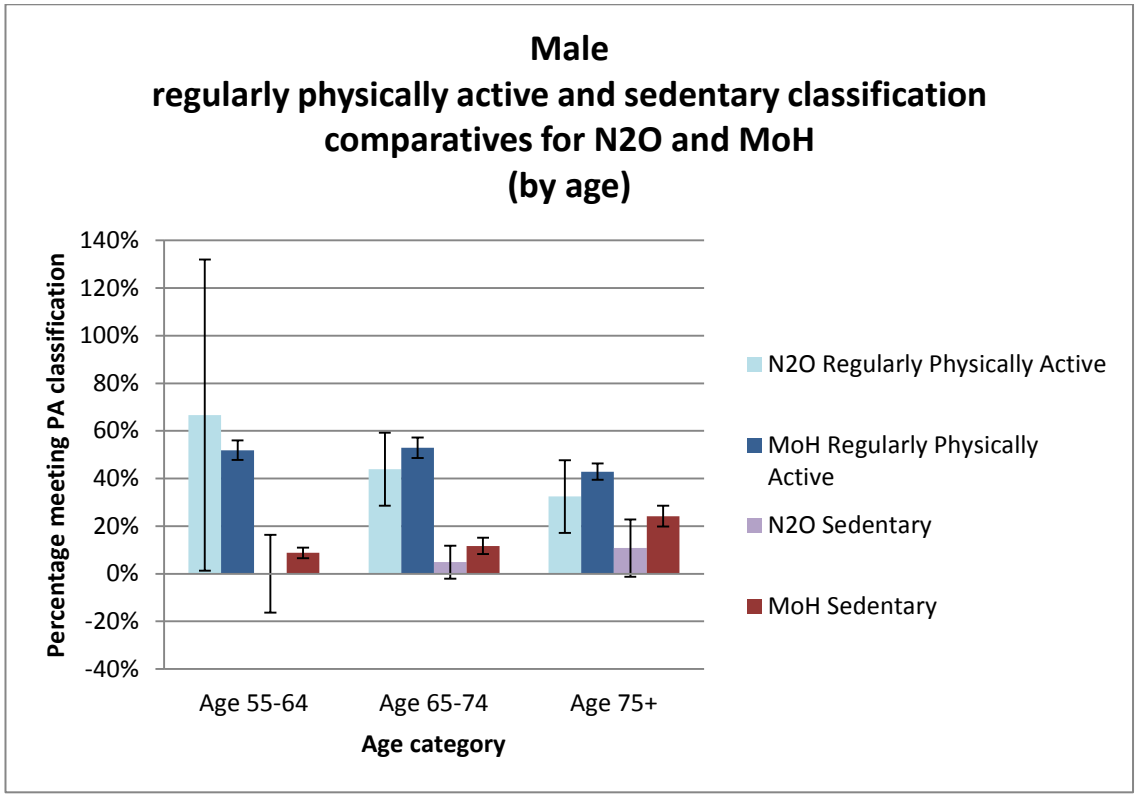


Note data are mean ± 2standard deviations
MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

As shown in Figure 8 for those females aged 55-64yrs and 65-74yrs a greater percentage of MoH tended to be classified as RPA than N2O. However none of the differences between MoH and N2O females classified as RPA were statistically significant in any of the three age groups. Differences between successive age groups were only significant in MoH females (between ages 65-74yrs and 75+yrs, 16.75 percentage point decrease). A greater percentage of MoH females were also classified as sedentary, with statistically significant increases in sedentary classification being found between those ages 65-74yrs and 75+yrs (20.60 percentage point increase). No statistically significant differences were found between successive age groups of N2O females.

Figure 9 shows no significant differences were found between N2O and MoH males classified as either RPA or sedentary in any of the three age groups. Changes between successive age groups were only statistically significant between MoH males aged 65-74yrs and 75+yrs who were classified as sedentary (increased by 12.50 percentage points). No statistically significant differences were found between successive age groups of N2O males for either RPA or sedentary classification.

Figure 9: Regularly physically active and sedentary classification comparatives for males (by age).



Note data are mean ± 2standard deviations
MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

While the MoH reported only RPA and sedentary behaviour, a middle group which could be described as Moderately Active also existed. As Table 12 shows 30% to 40% of MoH respondents would be classified as moderately active. For N2O members this percentage increased to over 50% for those aged 65-74yrs and 75+yrs. Differences in moderate activity classification between N2O and MoH were statistically significant in those aged 65-74yrs and 75+yrs.

Table 12: Comparative percentages of moderately PA classification (by age).

	N2O (95% confidence interval)	MoH (95% confidence interval)
55-64 years	33.33% (8.67-58.07)	39.30% (37.00-41.60)
65-74 years	51.22% (42.56-59.88)	35.40% (32.80-38.00)
75+ years	56.76% (45.90-67.62)	32.90% (30.06-35.74)

Note data are mean ± 2standard deviations
MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

Table 13 shows the changes in RPA and sedentary classification between successive age groups of N2O and MoH. By subtracting the MoH change (i.e. the control group) from the N2O change (i.e. the intervention group) difference-in-differences have also been calculated (refer last column Table 13). The purpose of performing this difference-in-differences analysis was to assist in isolating the effects that participation in the N2O programme may have had on RPA and sedentary behaviour across the three age groups. The formulae used to calculate difference-in-differences between successive age groups was $(N2O_n – N2O_{n-1}) – (MoH_n – MoH_{n-1})$. By subtracting the MoH change from that of the N2O, the true effects of participating in the N2O programme can be estimated. Given the small sample size in N2O members aged 55-64yrs these results have focused on the latter two age groups.

As Table 13 shows between ages 65-74yrs and 75+yrs RPA decreased by 14.90 percentage points for the MoH, and 6.35 percentage points for N2O members. Hence difference-in-differences analysis show N2O members had a smaller decline in RPA classification between successive age groups equated to 8.55 percentage points.

Gender comparisons showed between ages 65-74yrs and 75+yrs female RPA classification decreased by 18.00 and 4.55 percentage points for MoH and N2O, respectively. Males had a net decrease of 10.00 and 11.47 percentage

points, respectively. Hence difference-in-differences analysis show N2O females had a smaller decline in RPA classification between successive age groups equating to 13.45 percentage points, while N2O males had a greater decline in RPA classification equating to 1.47 percentage points (refer Appendix 7).

Net changes in sedentary behaviour, between ages 65-74yrs and 75+yrs, increased by 17.50 and 5.97 percentage points for MoH and N2O members respectively. Hence difference-in-differences analysis show N2O members had a smaller increase in sedentary classification between successive age groups, equating to 11.53 percentage points.

Gender comparisons showed that between ages 65-74yrs and 75+yrs female sedentary classification decreased by 20.60 and 7.95 percentage points respectively for MoH and N2O, while males had a 12.50 and 5.93 percentage point increase respectively. Therefore difference-in-differences analysis show N2O females had a smaller increase in sedentary classification between successive age groups, equating to 12.65 percentage points, while N2O males had a smaller increase equating to 6.57 percentage points (refer Appendix 7).

Table 13: Change in comparative RPA and sedentary classification

	MoH: Net percentage point change between successive age groups	N2O: Net percentage point change between successive age groups	Difference-in-differences percentage point between N2O and MoH*
Change in RPA:			
from 55-64yrs to 65-74yrs	2.50 decrease	2.79 decrease	0.29 decrease
from 65-74yrs to 75+yrs	14.90 decrease	6.35 decrease	8.55 increase
Total change	17.40 decrease	9.14 decrease	8.26 increase
Change in sedentary:			
from 55-64yrs to 65-74yrs	4.30 increase	3.41 increase	0.89 decrease
from 65-74yrs to 75+yrs	17.50 increase	5.97 increase	11.53 decrease
Total change	21.80 increase	9.38 increase	12.42 decrease

Difference-in-differences calculated as (N20n – N2On-1) – (MoHn – MoH n-1)
RPA-regularly physically active
MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

N2O intra group comparison

This section evaluates only N2O members. The evaluation is based on N2O members' level of engagement in the N2O i.e. which we refer to as 'volume', which was subsequently divided into three categories, being:

- high dose (>= 301 sessions/hours)
- medium dose (>=101 and <=300 sessions/hours)
- low dose (<=100 sessions/hours)

As might be expected there was a great deal of variability in N2O members' period of membership and average number of monthly sessions attended (refer Figure 10).

Figure 10: Scatter plot of N2O members' period of membership and session attendance (in months).

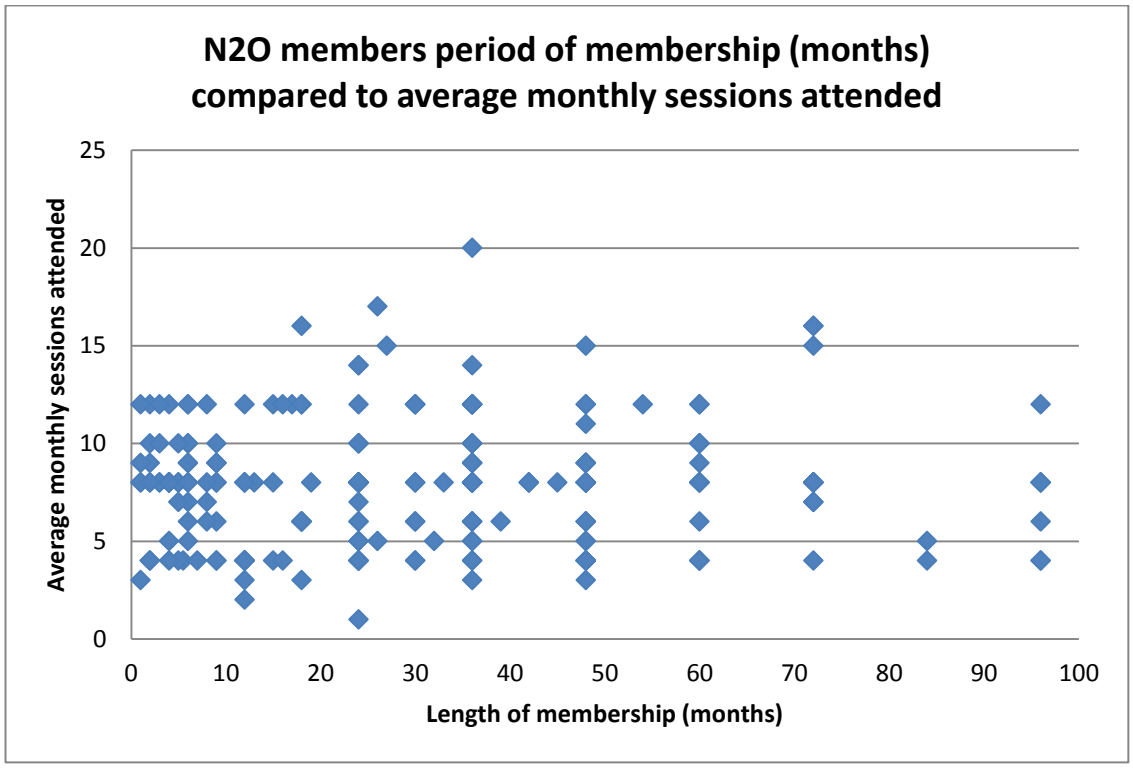
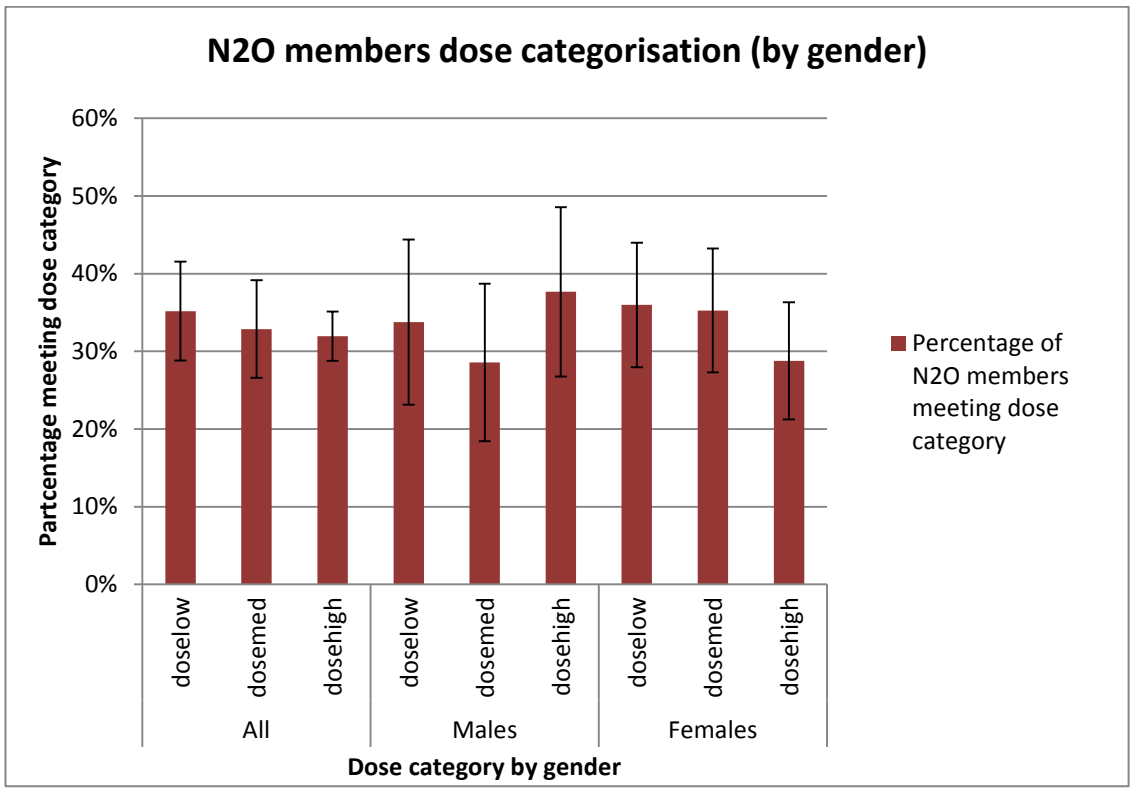


Figure 11 shows no significant differences were found between the percentages of N2O classified as high, medium or low dose, or between the percentage of males and females classified into the three dose categories.

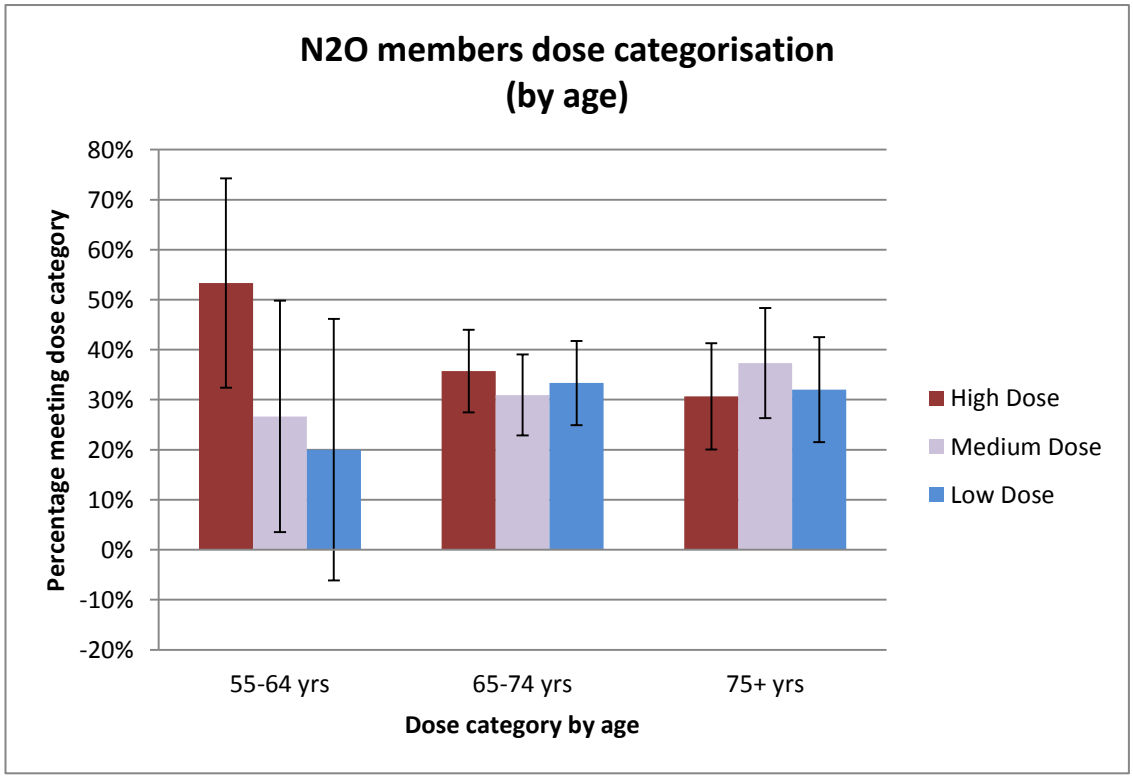
Likewise no significant differences were found between either the percentage of N2O members classified into each of the three dose categories based on age, nor between dose categorisation percentages within each of the three age groups (refer Figure 12).

Figure 11: N2O members' dose categorisation (by gender).



Note data are mean ± 2standard deviations
N2O-Never Too Old Active Aging programme study participants

Figure 12: N2O members' dose categorisation (by age).



Note data are mean ± 2standard deviations
N2O-Never Too Old Active Aging programme study participants

Analysis of period of membership showed that those aged 75+yrs had a mean membership period of 35.45 months, compared to 19.33 months for those aged 55-64yrs (refer Table 14). Gender comparisons showed N2O females had, generally, been N2O members longer than N2O males. With the exception of females ages 75+yrs little difference was found between either mean or median monthly sessions, either by age or gender.

Table 14: N2O members' membership period and monthly sessions (by age and gender).

	Mean period of membership (in months) (SD)	Median period of membership (in months)	Average monthly sessions attended (SD)	Median monthly sessions attended
All members	30.76 (23.84)	24	7.87 (3.18)	8
55-64yrs	19.33 (18.47)	12	8.07 (2.15)	8
65-74yrs	29.23 (23.12)	24	8.11 (3.18)	8
75+yrs	35.45 (25.13)	36	7.45 (3.32)	8
Male - All	29.74 (22.07)	24	8.52 (3.54)	8
55-64yrs	10.67 (6.43)	8	8 (2)	8
65-74yrs	27.5 (21.33)	24	8.65 (3.49)	8
75+yrs	34.06 (22.87)	36	8.42 (3.76)	8
Female - All	31.24 (24.83)	26	7.52 (2.90)	8
55-64yrs	21.5 (20.02)	18	8.08 (2.27)	8
65-74yrs	30.04 (23.99)	24	7.87 (3.01)	8
75+yrs	36.61 (27.09)	30	6.62 (2.66)	6

SD-Standard deviation

Regression analysis

Table 15 shows the only variable reaching a level of statistical significance was age, where for each one year increase in age the probability of being classified as RPA reduced by 1.43% (p-value=0.025), while the probability of being classified as sedentary increased by 1.36% (p-

value=0.019). Probit regression analysis found dose response scores did not have a significant effect on either the probability of being classified as RPA or sedentary.

Table 15: Probit regression analysis for PA classification and dose response score.

	RPA classification (SE)	Sedentary classification (SE)
Age	-0.0143*	0.0136*
	(0.0064)	(0.0058)
Female	-0.0959	0.0830
	(0.0763)	(0.0688)
Pre-existing PA health conditions	-0.0267	-0.0049
	(0.0287)	(0.0258)
Dose response score	0.0001	-0.0001
	(0.0002)	(0.0002)
Pseudo R2	0.0274	0.0284

SE-Standard error; RPA – Regularly physically active

**Significantly different from zero at 1% level using two-tailed *t* test.

*Significantly different from zero at 5% level using two-tailed *t* test.

As Table 16 shows, Probit regression analysis found statistically significant effects for sessions attended whereby for each additional monthly session attended decreased the probability of being classified as sedentary by 2.79% (p-value=0.012). Age also had a statistically significant effect on both period of membership and monthly sessions attended, and for both RPA and sedentary classifications. Period of membership had no significant effect on either RPA or sedentary classification.

Table 16: Probit regression analysis for RPA classification given level of longevity and intensity.

	RPA classification by period of membership (SE)	Sedentary classification by period of membership (SE)	RPA classification by average monthly sessions (SE)	Sedentary classification by average monthly sessions (SE)
Age	-0.036* (0.0065)	0.0123* (0.0059)	-0.0139* (0.0061)	0.0142* (0.0056)
Female	-0.0988 (0.0762)	0.0869 (0.0686)	-0.0688 (0.0771)	0.0549 (0.0708)
Pre-existing PA health conditions	-0.0289 (0.0285)	-0.0021 (0.0257)	-0.0240 (0.0287)	-0.0117 (0.0260)
Period of membership (months)	0.0001 (0.0015)	0.0007 (0.0014)		
Average monthly session attendance			0.0205 (0.0114)	-0.0279* (0.0111)
Pseudo R2	0.0241	0.0259	0.0426	0.0643

SE-Standard error; RPA – Regularly physically active

**Significantly different from zero at 1% level using two-tailed *t* test.

*Significantly different from zero at 5% level using two-tailed *t* test.

4.4.2 SF-36 Self rated health status

The SF-36 questionnaire was used to measure N2O members self-rated health status. The SF-36 consists of eight scale items, each of which can score between 1 and 100, with greater scores indicating better self-reported health. In addition to the eight individual scale items, scales items can be combined to produce summary physical health (Total PH) and summary mental health (Total MH) scores. It is noted that while Total PH and Total MH scores have been

calculated, the lack of individual MoH data has meant confidence intervals for this data were not able to be calculated.

National data comparison – MoH 2006/2007 New Zealand Health Survey:

As Table 17 shows statistically significant differences in scores were found between N2O and MoH in mental health (SFmh) across all three age groups. Statistically significant differences were also found in all but bodily pain (SFbp) for those aged 75+yrs. For those aged 65-74yrs, statistically significant scores were found in all scale items except general health (SFgh) and role emotional (SFre). Gender analysis found statistically significant score differences in physical function (SFpf) for males aged 55-64yrs (decrease of 21.23 points), and females aged 75+yrs (increase of 27.84 points) (refer Appendix 8 and 9).

Table 17: Comparative SF-36 mean health scale scores by age.

Group	Age group (years)	SFpf (95% confidence)	SFrp (95% confidence)	SFbp (95% confidence)	SFgh (95% confidence)	SFv (95% confidence)	SFsf (95% confidence)	SFre (95% confidence)	SFmh (95% confidence)
N2O	55-64yrs	83.67	83.04*	69.00	69.21	61.61	91.10	87.78*	75.71*
		(79.8-87.5)	(76.3-89.8)	(61.9-76.0)	(63.5-74.9)	(56.6-66.6)	(79.7-90.4)	(81.8-93.8)	(70.1-81.3)
MoH		81.3	83.2	73.0	73.6	65.0	89.0	94.6	84.6
		(80.1-82.6)	(81.9-84.5)	(71.6-74.5)	(72.5-74.6)	(64.1-66.0)	(88.0-90.1)	(93.9-95.4)	(83.9-85.2)
N2O	65-74yrs	83.95*	82.39*	75.10*	76.18	66.98*	93.00*	92.51	82.76*
		(82.5-85.4)	(80.2-84.5)	(73.2-77.0)	(63.5-74.9)	(65.7-68.2)	(91.5-94.4)	(91.0-94.0)	(81.7-83.9)
MoH		73.6	76.5	70.1	71.0	64.3	88.1	94.2	85.2
		(71.9-75.2)	(74.6-78.5)	(68.2-71.9)	(69.5-72.4)	(63.0-65.6)	(86.7-89.5)	(93.3-95.1)	(84.5-86.0)
N2O	75+yrs	77.14*	77.52*	70.63	77.16*	63.07*	89.14*	87.67*	81.82*
		(74.6-79.7)	(74.7-80.3)	(67.8-73.4)	(75.0-79.3)	(61.1-65.0)	(86.9-91.4)	(85.4-89.9)	(80.2-83.5)
MoH		56.2	63.5	68.8	67.5	58.9	82.4	91.6	84.9
		(54.2-58.1)	(61.0-66.0)	(67.1-70.5)	(65.9-69.0)	(57.5-60.3)	(80.6-84.2)	(90.3-93.0)	(84.0-85.9)

*Statistically significant differences in N2O scores compared to MoH scores based on non overlapping confidence intervals.

Table 18 shows the changes in SF-36 scores between successive age groups of N2O and MoH. With the exception of mental health (SFmh) between those age 55-64yrs to 65-74yrs, changes in MoH scores between successive age groups were negative (i.e. MoH SF-36 scores decreased with increasing age). For N2O members changes in SF-36 scores between those aged 55-64yrs to 65-74yrs were, with the exception of role physical (SFrp), positive (i.e. N2O SF-36 scores increased with increasing age group). However the small sample size for those aged 55-64yrs is noted. In contrast changes in SF-36 scores between N2O members aged 65-74yrs to 75+yrs were, with the exception of general health (SFgh), negative (i.e. N2O members' scores decreased with increasing age).

Gender comparisons showed that with the exception of vitality (SFv) and mental health (SFmh) in MoH males between 55-64yrs to 64-75yrs, MoH scores for both genders and all age groups decreased with increasing age. Changes between N2O aged 55-64yr and 65-74yrs increased in all but physical function (SFpf) and role physical (SFrp) for females. In contrast changes in SF-36 scores between N2O members aged 65-74yrs to 75+yrs were, with the exception of general health (SFgh), negative in both genders (refer Appendix 10 and 11).

By subtracting the MoH change (i.e. the control group) from the N2O change (i.e. the intervention group) difference-in-differences have also been calculated (refer Table 19). The purpose of performing this difference-in-differences analysis was to assist in isolating the effects that participation in the N2O programme may have had on health status. The formulae used to calculate difference-in-differences between successive age groups was (N2On – N2On-1) – (MoHn – MoHn-1).

When difference-in-differences for SF-36 scores between N2O members and MoH were calculated between those aged 65-74yrs to 75+yrs (as per Table 19), N2O members generally showed positive changes in scores. The exceptions were bodily pain (SFbp); role emotion (SFre); vitality (SFv, males only) and mental health (SFmh, males only). These relative improvements were generally greater in physical health items (i.e. SFpf, SFrp, SFbp, SFgh, and SFv) than in mental health items (i.e. SFgh, SFv, SFsf, SFre, and SFmh). Overall N2O females had a relative increase in Total PH from age 64-74yrs to 75+yrs of 6.52 points while N2O males had a relative increase of 2.12 points.

Table 18: Net change in mean SF-36 scores between successive age groups for N2O members and MoH.

Group	Age group (years)	SFpf	SFrp	SFbp	SFgh	SFv	SFsf	SFre	SFmh	Total PH	Total MH
MoH	55-64yrs to 65-74yrs	-7.70	-6.70	-2.90	-2.60	-0.70	-0.90	-0.40	0.60	-4.12	-0.80
N2O		0.28	-0.64	6.10	6.97	5.37	7.97	4.74	7.04	3.62	6.42
MoH	65-74yrs to 75+yrs	-17.40	-13.00	-1.30	-3.50	-5.40	-5.70	-2.60	-0.30	-8.12	-3.50
N2O		-6.81	-4.87	-4.47	0.98	-3.91	-3.82	-4.84	-0.94	-3.82	-2.51

Note: negative indicates a decrease in scores between the successive age groups

Table 19: Difference-in-differences analysis of SF-36 scores between N2O members and MoH (by age and gender).

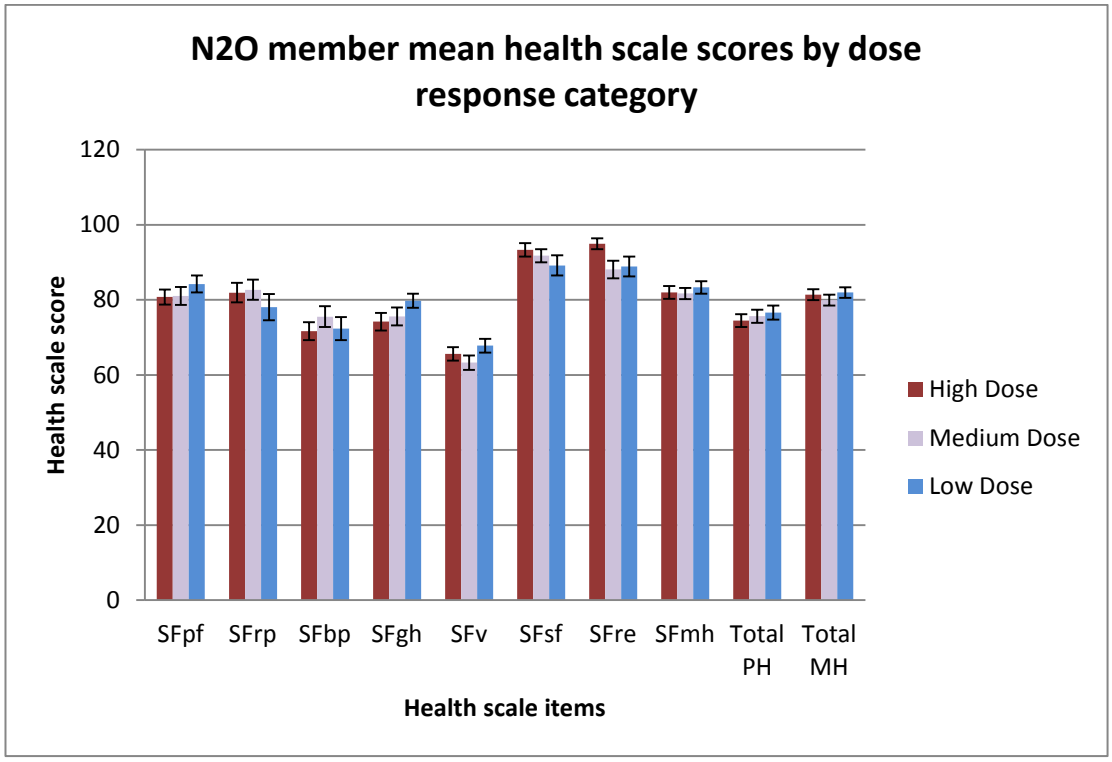
Group	Age group (years)	SFpf	SFrp	SFbp	SFgh	SFv	SFsf	SFre	SFmh	Total PH	Total MH
Total	55-64yrs to 65-74yrs	7.98	6.06	9.00	9.57	6.07	8.87	5.14	6.44	7.74	7.22
Male		29.63	17.30	18.21	10.68	8.87	10.67	10.95	9.93	16.94	10.22
Female		3.79	4.50	7.13	10.52	6.77	8.17	4.43	5.93	6.54	7.16
Total	65-74yrs to 75+yrs	10.59	8.13	-3.17	4.48	1.49	1.88	-2.24	-0.64	4.30	0.99
Male		3.41	9.00	-7.94	6.80	-0.68	1.74	-0.45	-3.48	2.12	0.79
Female		14.68	9.62	-0.52	4.45	4.36	1.70	-2.11	1.41	6.52	1.96

Note: negative indicates a relative decrease in N2O members' scores compared to MoH

MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

N2O intra group comparison

Figure 13: N2O members mean SF-36 health scale scores (by dose category)



Note data are mean ± 2standard deviations

Figure 13 shows statistically significant differences between high and low dose N2O members were only found in general health (SFgh) and role emotional (SFre). Statistically significant differences were also found between high and medium dose N2O members in role emotional (SFre).

Regression analysis

Table 20 shows dose response score only had a statistically significant effect on role emotional (SFre) (p-value=0.021) where a one hour increase in dose response score decreased role emotional score by 0.012 points. Period of membership also had a statistically significant effect on role emotional whereby an additional months membership decreasing the score by 0.1566 points (refer Appendix 12). Average monthly sessions attended had a statistically significant effect on vitality (SFv) whereby one extra session per month increasing the health score by .7815 points (refer Appendix 13).

While age and gender were found to have a statistically significant effect across several different scale items, pre-existing PA health conditions had the

broadest effect, having statistically significant effects on all scale items except social function (SFsf) and mental health (SFmh).

Table 20: Regression analysis for SF-36 health scale scores by dose response score.

	SFpf (SE)	SFrp (SE)	SFbp (SE)	SFgh (SE)	SFv (SE)	SFsf (SE)	SFre (SE)	SFmh (SE)	Total PH (SE)	Total MH (SE)
Age	-0.5873**	-0.5107	-0.1049	0.3500	-0.1624	-0.0889	-0.2363	0.0750	-0.2315	-0.0869
	(0.2099)	(0.2805)	(0.2610)	(0.2136)	(0.1747)	(0.2102)	(0.2074)	(0.1627)	(0.1667)	(0.1407)
Female	0.0710	8.4084*	-0.8153	4.7638	5.0198*	-1.6811	4.5466	1.4174	3.2094	2.3909
	(2.6144)	(3.4386)	(3.2503)	(2.6442)	(2.1635)	(0.9479)	(2.5889)	(2.0150)	(2.0663)	(1.7526)
Pre-existing PA	-2.8559**	-3.3213**	-4.930**	-3.3928**	-2.8830**	-0.2544	-2.7545**	0.2581	-3.4777**	-1.7397*
health conditions	(0.9651)	(1.2607)	(1.1921)	(0.9646)	(0.7899)	(0.9480)	(0.9441)	(0.7357)	(0.7593)	(0.6428)
Dose response	0.0062	-0.0050	-0.0040	0.0083	0.0067	-0.0068	-0.0125*	0.0024	0.0031	0.0008
score	(0.0055)	(0.0072)	(0.0068)	(0.0055)	(0.0045)	(0.0054)	(0.0054)	(0.0042)	(0.0043)	(0.0037)
R2	0.0814	0.0899	0.0773	0.1000	0.1098	0.0107	0.0931	0.0050	0.1209	0.0504

SE-Standard error

**Significantly different from zero at 1% level using two-tailed *t* test.

*Significantly different from zero at 5% level using two-tailed *t* test.

4.4.3 Health care service utilisation

For comparison purposes health services were divided into four categories being general practitioner (GP), complementary/alternative health care, medical specialists and hospital. It should be noted that MoH utilisation comparatives were limited to whether or not a particular health care service was used, while N2O sub-group analysis also included frequency of utilisation (i.e. how often a service was utilised).

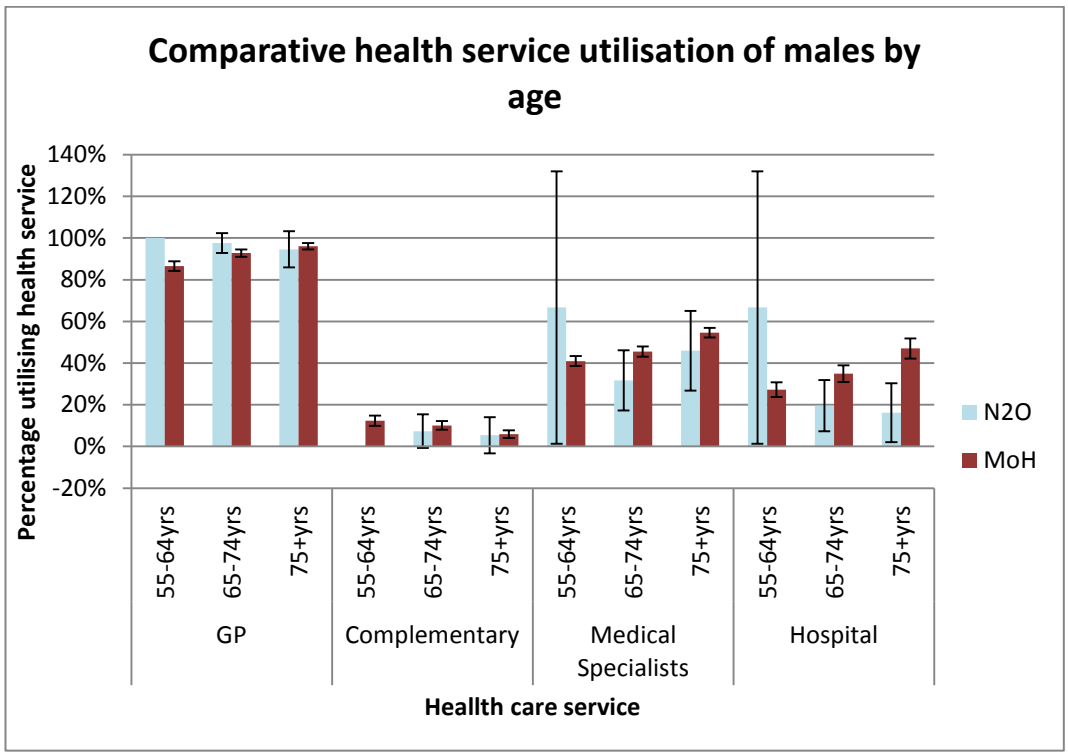
National data comparison – MoH 2006/2007 New Zealand Health Survey:

It is noted that analysis in this section is limited to gender specific data. Furthermore confidence intervals have not been calculated for those variables in which no variation was found. This primarily occurred in N2O members aged 55-64yrs where the sample size was small.

As can be seen in Figure 14 the only statistically significant difference between N2O and MoH males' utilisation was found in hospital services for those aged 65-74yrs (30.78 percentage points). Whilst MoH males generally showed statistically significant differences in utilisation of health care services between successive age groups (i.e. utilisation typically increased with age), no significant differences in utilisation were found between successive age groups of N2O males.

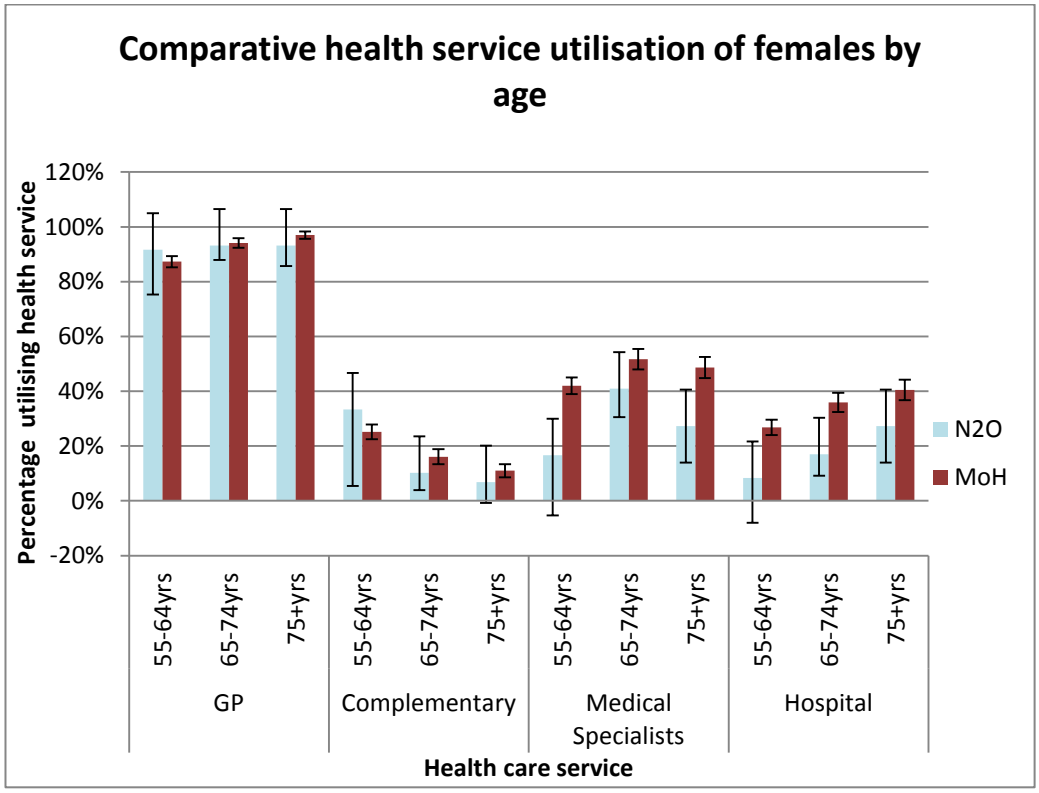
Statistically significant differences between N2O and MoH female utilisation rates were found in medical specialists for those aged 55-64yrs (25.33 percentage points) and 75+yrs (21.43 percentage points). Statistically significant differences were also found in hospital use for those aged 55-64yrs (18.47 percentage points) and 65-74yrs (18.85 percentage points) (refer Figure 15). While MoH results showed statistically significant differences in health care service utilisation between successive age groups of females, differences between successive N2O females were not significant.

Figure 14: Comparative male health care service utilisation (by age).



Note data are mean ± 2standard deviations
MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

Figure 15: Comparative female health care service utilisation (by age).

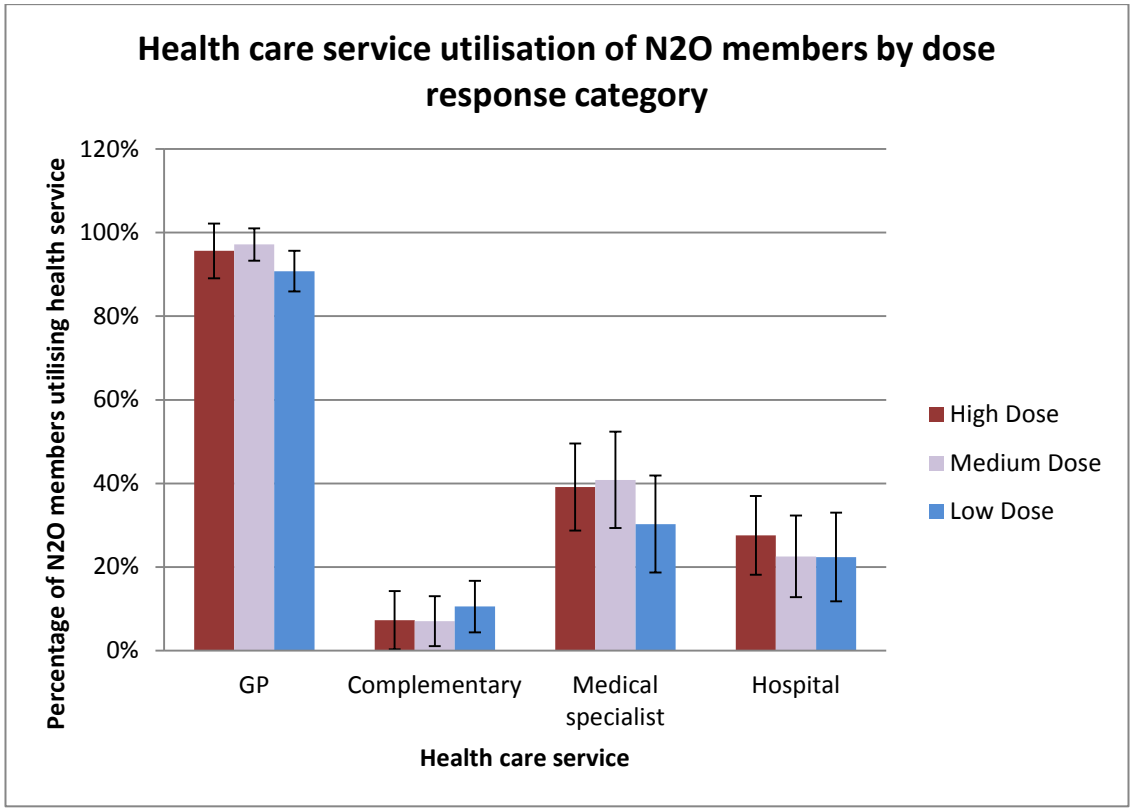


Note data are mean ± 2standard deviations
MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

N2O intra group comparison

It is noted that N2O sub-group health care service utilisation analysis uses both utilisation (i.e. did or did not use the service) and frequency (i.e. number of times health care service utilised). As Figure 16 shows there were no significant differences in health care service utilisation rates between the three N2O member dose categories.

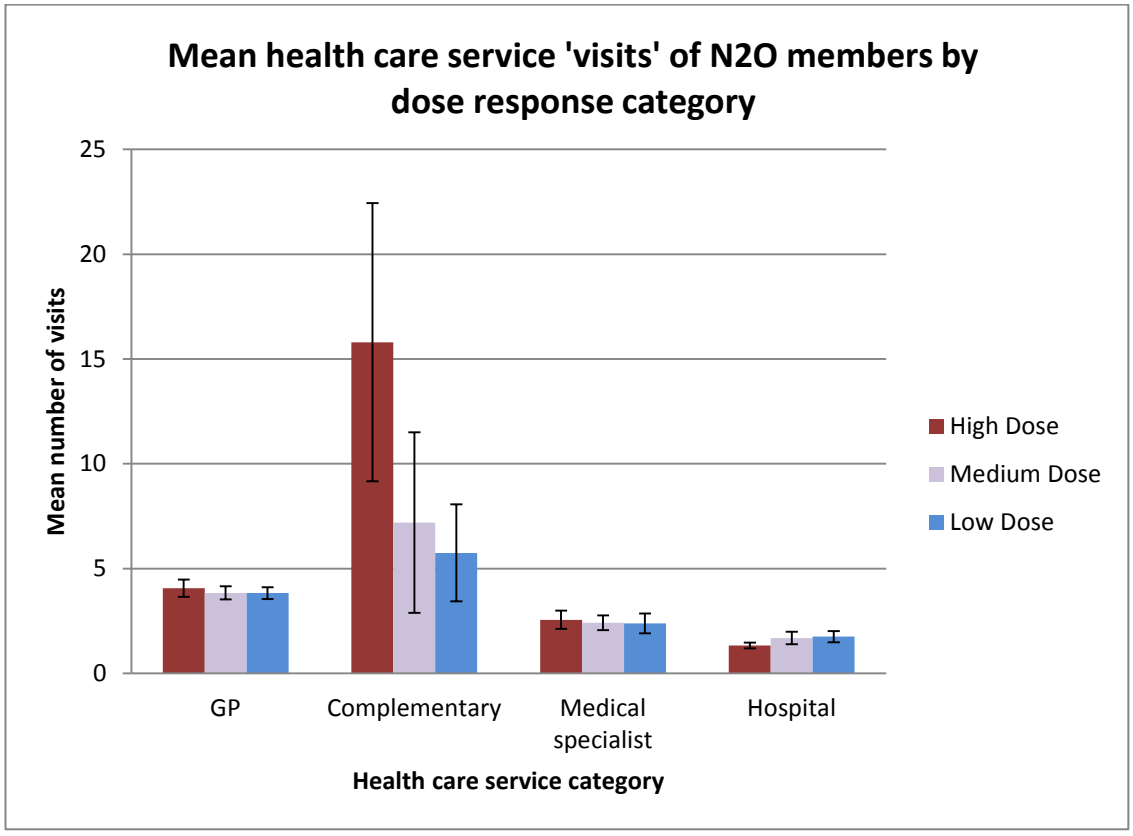
Figure 16: Health care service utilisation of N2O members by dose response category.



Note data are mean ± 2standard deviations
N2O-Never Too Old Active Aging programme study participants

Figure 17 also shows that the only statistically significant difference in frequency of health care service utilisation (i.e. number of visits) was found in complementary health services between high and low dose N2O members (10.05 visits).

Figure 17: Mean number of health care service visits of N2O members by dose response category.



Note data are mean ± 2standard deviations

N2O-Never Too Old Active Aging programme study participants

Regression analysis

As Table 21 shows for complementary health services age reached a level of statistical significance (p-value=0.016) where a one year increase in age reduced the probability of using that service by .75%. For GP utilisation the presence of a pre-existing PA health condition had a statistically significant effect, increasing the probability of utilising a GP by 2.78% (p-value=0.048). Neither period of membership nor average monthly session attendance had a significant effect on any health care service utilisation (refer Appendix 14 and 15).

Table 21: Probit regression analysis for dose response score and health care service utilisation.

	GP (SE)	Complementary health care services (SE)	Medical specialist (SE)	Hospital (SE)
Age	-0.0013	-0.0075*	-0.0045	-0.0080
	(0.0018)	(0.0030)	(0.0057)	(0.0050)
Gender	-0.0352	0.0466	-0.0567	0.0024
	(0.0222)	(0.0346)	(0.0703)	(0.0612)
Pre-existing PA health conditions	0.0278*	-0.0034	0.01929	-0.0057
	(0.0115)	(0.0145)	(0.0255)	(0.0231)
Dose response	0.0001	0.0001	0.0001	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Pseudo R2	0.1064	0.0816	0.0085	0.0129

SE-Standard error

**Significantly different from zero at 1% level using two-tailed *t* test.

*Significantly different from zero at 5% level using two-tailed *t* test.

Dose response score was found to have a statistically significant effect on frequency of use (i.e. number of visits) for complementary health care, whereby a one hour increase in dose response increased the number of visits by 0.022 times (p-value=0.033) (refer Table 22). A statistically significant effect on complementary health services was also found for period of membership, whereby an extra month's membership increased visits by 0.210 times. Pre-existing PA health conditions were also found to have a statistically significant effect on GP visits (refer Appendix 16 and 17).

Table 22: Linear regression analysis for dose response score and frequency of health care service utilisation (visits).

	GP (SE)	Complementary health care services (SE)	Medical specialist (SE)	Hospital (SE)
Age	0.0032	0.1139	0.0379	-0.0208
	(0.0313)	(0.3871)	(0.0468)	(0.0231)
Gender	0.0964	4.6642	0.4866	-0.0886
	(0.3901)	(6.5154)	(0.4958)	(0.2861)
Pre-existing PA health conditions	0.7208**	-0.4974	-0.2146	0.0903
	(0.1430)	(2.3217)	(0.1873)	(0.1165)
Dose response	0.0003	0.0220*	-0.0011	-0.0008
	(0.0009)	(0.0092)	(0.0011)	(0.0006)
R2	0.1132	0.4813	0.0413	0.0757

SE-Standard error

**Significantly different from zero at 1% level using two-tailed *t* test.

*Significantly different from zero at 5% level using two-tailed *t* test.

4.4.4 Health care expenditure

No MoH comparative data was available for this variable; hence analysis has been limited to N2O member sub-groups based on the three health care expenditure categories of primary health care, complementary health and medical specialists.

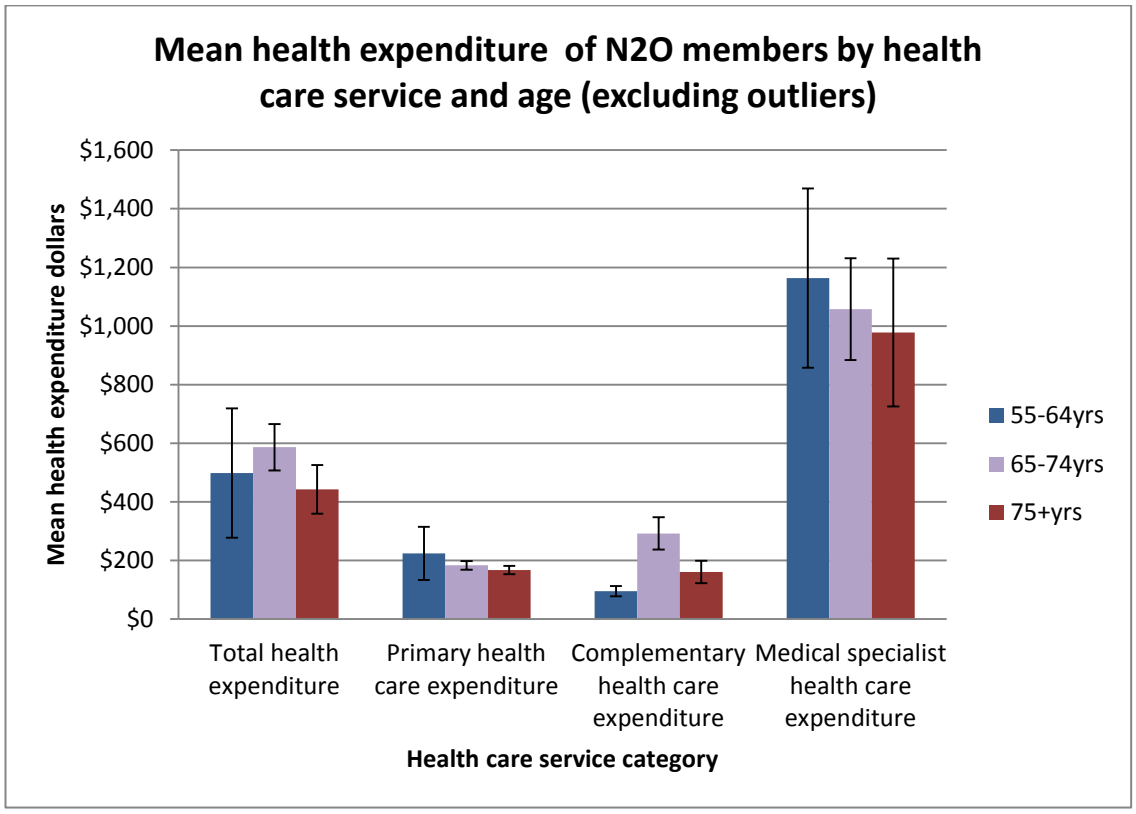
Preliminary analysis of health expenditure data suggested that N2O members' data were skewed or included unusual items. Investigation of N2O members' expenditure by the researcher identified nine individuals with unusually high health expenditure atypical of the N2O group. The expenditure for these nine individuals totalled $110,855 and included expenses for hip replacement (n=1, $24,000), cancer surgery (n=3, $15,000; $5,000; $5,180), retina surgery (n=1, $10,200), ear/nose/throat surgery (n=3, $5,947; $6,688; $9,840) and a single individual with combined unspecified surgical expenses of $29,000. While these were valid health care expenses, it was decided that these observations should be removed as outliers given their unusual nature and their inability (the possible exception being cancer) to be modified by the

independent variable. Removal of these outliers only affected medical specialist health expenditure.

N2O intra group comparison

Figure 18 shows that, based on age, only complementary health care expenditure of N2O had statistically significant differences ($95.00, $292.16, $160.44, youngest to oldest age groups respectively).

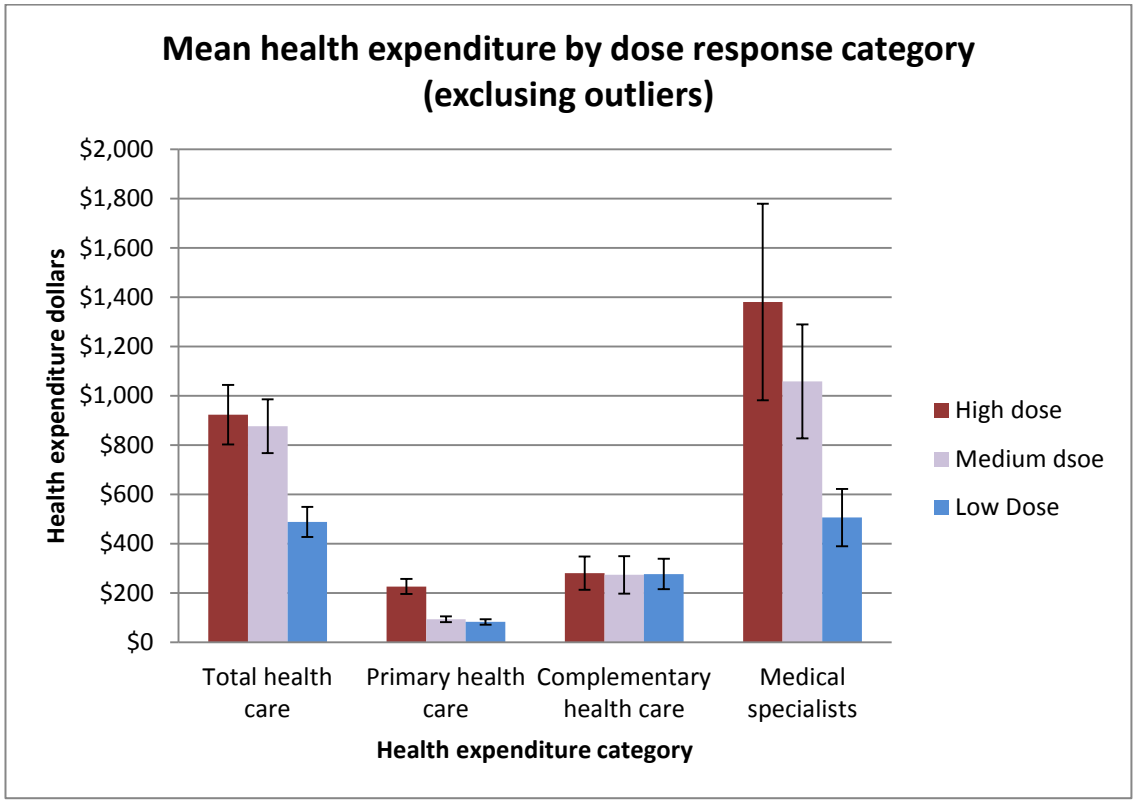
Figure 18: Mean health expenditure of N2O members by health care service and age (excluding outliers).



Note data are mean ± 2standard deviations

Figure 19 shows that dose response score had a statistically significant effect on primary health care and medical specialist expenditure. In both these health care expenditure categories high dose N2O members incurred greater expenses than low dose N2O members (differences in primary health care $143.46, differences in medical specialists $974.90).

Figure 19: Mean health expenditure of N2O members by dose response classification (excluding outliers).



Note data are mean ± 2standard deviations

Regression analysis

As can be seen in the scatter plot below (refer Figure 20) individual N2O total health care expenditure varied greatly with respect to dose response score.

Regression analysis showed the only variable with a statistically significant effect on health expenditure was pre-existing PA health conditions, which showed a $17.86 increase in primary health care expenditure (p-value=0.047) (refer Table 23). Dose response score had no statistically significant effects on any health care expenditure items. Similarly neither period of membership nor average monthly sessions attended were found to have a statistically significant effect on health expenditure (refer Appendix 18 and 19).

Figure 20: Scatter plot of total health care expenditure against dose response score (excluding outliers).

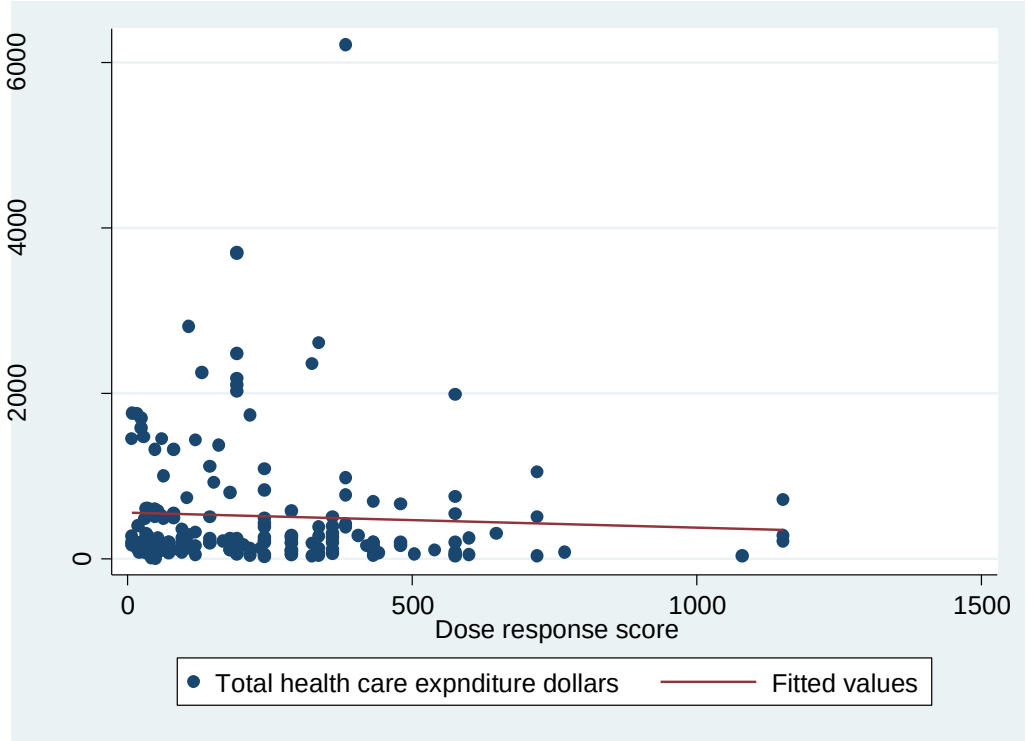


Table 23: Regression analysis of dose response score on health expenditure.

	Total health expenditure (SE)	Primary care (SE)	Complementary (SE)	Medical specialist (SE)
Age	-9.6745	-2.469	-2.7821	-14.8938
	(9.8661)	(1.910)	(7.5641)	(28.6660)
Female	56.6473	-17.6442	38.4112	66.6149
	(122.9922)	(23.1822)	(93.3630)	(325.1699)
Pre-existing	8.8395	17.8614*	19.6593	22.2046
PA Health	(47.2972)	(8.9076)	(31.2444)	(140.3517)
condition				
Dose	-0.1428	0.06229	0.1108	-0.3585
response	(0.2624)	(0.04925)	(0.1614)	(0.7082)
score				
R2	0.0100	0.0394	0.0236	0.0119

SE-Standard error

**Significantly different from zero at 1% level using two-tailed *t* test.

*Significantly different from zero at 5% level using two-tailed *t* test.

4.4.5 Falls

No comparative MoH data was available for this variable; hence analysis has focused on N2O members sub-group comparisons.

N2O intra group comparison

Table 24 shows 19.11% of N2O members had experienced a fall in the previous twelve months, with those aged 75+yrs having the greatest number of fallers. Just over two percent of N2O members had a fall resulting in a severe injury, with those aged 75+yrs having the greatest number of severe falls (3.71%). N2O females experienced both more falls and more severe falls than N2O males across all three age groups.

Table 24: Fall frequency and severity for N2O members (by age and gender).

		Percentage who had a fall	Percentage of severe injury falls	Median number of falls (maximum)
All	Total (n=225)	19.11% (n=43)	2.67% (n=6)	1 (6)
	55-64yrs (n=15)	13.33% (n=2)	0.00%	1
	65-74yrs (n=129)	13.95% (n=18)	2.33% (n=3)	1 (4)
	75+yrs (n=81)	28.40% (n=23)	3.71% (n=3)	1 (6)
Males	Total (n=81)	17.28% (n=14)	1.23% (n=1)	1 (5)
	55-64yrs (n=3)	66.67% (n=2)	0.00%	1
	65-74yrs (n=41)	4.88% (n=2)	0.00%	1 (2)
	75+yrs (n=37)	27.03% (n=10)	3.34% (n=1)	1 (5)
Females	Total (n=144)	20.14% (n=28)	3.47% (n=5)	1 (6)
	55-64yrs (n=12)	0.00%	0.00%	1
	65-74yrs (n=88)	18.18% (n=15)	3.41% (n=3)	1 (2)
	75+yrs (n=44)	29.55% (n=13)	4.55% (n=2)	1 (6)

As can be seen in Table 25 there were no statistically significant differences in fall rates or severity of falls between the three N2O member dose categories.

Table 25: N2O member fall occurrence and severity by dose category.

	Percentage of N2O who had a fall (95% confidence interval)	Percentage of falls resulting in severe injury (95% confidence interval)
Low dose (n=73)	20.55% (n=15) (11.22%-29.88%)	0.00%
Medium Dose (n=63)	20.63% (n=13) (10.56%-30.70%)	23.08% (n=3) (-0.76%-46.92%)
High dose (n=65)	16.92% (n=11) (7.73%-26.11%)	18.18% (n=2) (-5.72%-42.08%)

Regression analysis

Probit regression analysis, as per Table 26, showed that neither dose response score, period of membership nor average monthly session attendance had a statistically significant effect on falls. Statistically significant effects were found for pre-existing PA health conditions across all three dose variables (i.e. dose, period and attendance) and for age in respect to dose response score and average monthly sessions attended.

Table 26: Probit regression analysis for falls based on dose response score, period of membership and average monthly sessions.

	Falls by dose (SE)	Falls by period of membership (SE)	Falls by average monthly sessions attended (SE)
Age	0.0091*	0.0080	0.0093*
	(0.0046)	(0.0044)	(0.0047)
Female	0.0461	0.0321	0.0514
	(0.0558)	(0.0569)	(0.0559)
Pre-existing PA health conditions	0.0474* (0.2009)	0.0470* (0.0202)	0.0494* (0.0202)
Dose response score	-0.0002 (0.0001)		
Period of membership		-0.0065 (0.0093)	
Average monthly sessions			-0.0008 (0.0012)
Pseudo R2	0.0555	0.0495	0.0492

SE-Standard error

**Significantly different from zero at 1% level using two-tailed *t* test.

*Significantly different from zero at 5% level using two-tailed *t* test.

4.4.6 Qualitative 'benefits' of N2O

For analysis purposes no distinction was made between the types of benefits i.e. whether they were health or non-health related, or whether they were physiological or psychological, given the many of the benefits identified had an interdependent nature. None of the benefits identified were quantitatively measured or independently verified.

Of the 225 N2O members who participated in this study only five indicated they had not noticed any benefits from participation in the programme. However, of these five individuals, three noted they were new to the N2O (members for less than six months). Hence 97.78% of N2O members indicated they had 'benefited' from their involvement in the N2O. Nearly all (98.12%) of N2O members who indicated a N2O benefit also indicated multiple benefits. The average number of benefits identified being three.

As shown in Table 27 the most frequent benefit identified was that N2O members felt stronger (50.67%). These improvements in strength were qualified by comments about how they were better able to 'cope' with daily activities, for example house hold chores like carrying groceries, lifting heavier loads, 'heaving' things around the garden. Improved balance was the second most frequent comment with 34.22% (n=77) of N2O members indicating that they felt they had improved in this area. Several N2O members also commented that they felt their improvements in balance were a contributing factor to having not experienced a fall in that time. This was in addition to 8% who indicated falls, either the lack of or prevention of, was a benefit associated with being involved in the N2O. The third most common benefit identified was improved fitness, cited by 32.44% of the N2O members.

Other interesting comments noted included:

- Participation in the N2O provided comradeship and an opportunity to socialise, meet people, make friends and have company and companionship (28.89%). Many commented that it was this 'social' aspect of the N2O programme that made attendance fun and enjoyable.
- Improvements in 'mental' health including better mood, better mental attitude, feeling 'happier' and feeling less depressed (16.89%).
- Greater sense of wellbeing (14.22%).
- Improvements in blood pressure (assessed by either lower BP readings or a reduction in medication) (14.22%).
- Aid in pain management (i.e. reduction in pain or reduced need for pain medication) (8.89%).
- "Anti-aging effects" (1.78%). Comments included "keeping the aging process at bay" and "noticing other people my age who do not do some sort of activity aging faster than myself".

Table 27: Summary of N2O benefits as identified by N2O members.

Benefit identified	Number of N2O member responses	Percentage of N2O members making comment
Strength	114	50.67%
Balance	77	34.22%
Fitter	73	32.44%
Social aspects	65	28.89%
Fun/enjoyment	40	17.78%
"Mental" aspects	38	16.89%
Wellbeing	33	14.67%
Blood pressure	32	14.22%
Flexibility/mobility	29	12.89%
Healthier	23	10.22%
Weight	21	9.33%
Pain	20	8.89%
Falls	18	8.00%
Vitality/energy	17	7.56%
Endurance/stamina	13	5.78%
Breathing	13	5.78%
Physique	9	4.00%
Sleep	8	3.56%
Bone density	6	2.67%
Coordination	6	2.67%
Confidence	5	2.22%
"Anti-aging"	4	1.78%
Diet/appetite	3	1.33%

4.4.7 N2O costs and economic assessment

N2O costs

Seven N2O providers supplied financial data on the costs associated with providing the N2O. These data were reported for financial periods between January 2009 and December 2010 and are shown in Table 28.

Based on a 49 week period, the average annual cost of providing the N2O was calculated as $24,627.02 (NZ$172,389 divided by seven N2O providers). Given 20 N2O sessions were provided per week, over a 49 week period, this equated to an average session cost of $175.91 ($172,389 divided by 980 sessions).

Using N2O provider F (who provided the most comprehensive and complete data, refer Table 28) the estimated session cost per attending N2O member was calculated as $10.12. This was based on an average of 28 N2O members attended each of the sessions run by provider F (NZ$283.24 divided by 28 N2O members). It was assumed that each N2O provider's costs were relative to their respective N2O member numbers. e.g., N2O provider A, given their average sessions costs of $50.46, were assumed to have, on average, five members attending each of their sessions (NZ$50.46 divided by the average cost per attendee $10.12). This estimated provider session cost per attending N2O member of $10.12 will be used in subsequent calculations in this thesis.

Table 28: Annual N2O programmes costs.

N2O provider	Sessions per week	Programme coordinators/ instructors	Printing/ Promotion	Special Equipment	Travel	Franchise Fees	Training	Refreshments	IT	Facility 'rental'	TOTAL ANNUAL PROGRAMME COSTS	Average cost per session (assumed 49 weeks)
A	3	4,500	400	300	150	1,637		430			7,417	50.46
B	2	5,000	400	0	100		0			0	5,500	56.12
C1&2	3	9,360	0	400	1,500	5,000	0			0	16,260	110.61
D	3	17,784	750	200	50		500			12,480	31,764	216.08
E	2	7,560	1,207	402	1,008	4,000		120			14,297	145.90
F	7	89,150	3,800	500			0		200	3,500	97,150	283.24
Total sessions per month	20											
Total costs NZ$		133,354	6,557	1,802	2,808	10,637	500	550	200	15,980	172,389	

N2O economic assessment

Two significant findings were identified in the PA results (refer section 4.4.1). Firstly N2O members had lower rates of sedentary behaviour compared to the MoH. Overall 16.90% of the MoH older adults were classified as sedentary compared to 12.00% of N2O members. This translates into a decrease in sedentary behaviour of 4.90 percentage points for the N2O group.

Secondly, N2O members had smaller increases in sedentary classification between successive age groups. This equated to a relative improvement in N2O sedentary behaviour of 12.42 percentage points (Refer table 13). These findings suggest that N2O members, in comparison to MoH, were more likely to maintain their PA with increasing age.

These changes in N2O members' sedentary behaviour form the basis for calculating the potential economic benefits of the N2O. These represent the potential health costs associated with physical inactivity that could be prevented or eliminated if older New Zealanders were to participate in the N2O. The economic assessment was based on a cost of illness model and utilised data described below (refer section 3.3.4 for more detailed information).

i) Population attributable risk (PAR) formulae:

$$\frac{\text{Prevalence of population health risk factor} * (\text{Relative Risk} - 1)}{1 + \text{Prevalence of population health risk factor} * (\text{Relative Risk} - 1)}$$

ii) Current prevalence of health risk factor – Sedentary: 16.90%; Physically inactive 53.12% (Ministry of Health, 2008).

iii) Relative Risk (RR) values for physical inactivity: 1.25 all-cause mortality (Tobias & Roberts, 2001).

iv) Population: 564,500 (Statistics New Zealand, 2011)

v) Mortality due to physical inactivity: estimated at 1,901 deaths per annum (Ministry of Health, 2003a, 2011).

vi) Older adult health expenditure: estimated at NZ$5251.2million per annum (Fletcher & Lynn, 2002).

Table 29 shows the economic affect if sedentary behaviour in New Zealand older adults were to be reduced by 4.90 percentage points i.e. if the older adult population in New Zealand were to reduce their sedentary rates to the same level as that of N2O members of 12%. This 4.90 percentage point decrease represents a 25% decrease in current sedentary behaviour in older New Zealand adults. The results indicate that potentially 22 older adult deaths could be averted and NZ$59.86million (0.01%) of older adult health care expenditure could be 'saved' per annum. Per capita this equates to one less death for every 25659 older adults and NZ$106.04 savings in health expenditure per older adult per annum.

Table 30 shows the economic effect if the relative improvements in N2O sedentary behaviour found between successive age groups could be applied to the older adult population in New Zealand (i.e. if the older adult population in New Zealand were able to maintain their PA with advancing age at the same level as that of N2O members). The change required would be a 12.42 percentage point decrease in physical inactive levels (note physically inactive are those who do not meet RPA classification). This represents a 23.38% decrease in current physically inactive older adults. It is estimated that this could result in 47 fewer older adult deaths and 'savings' of NZ$130.23million (0.02%) in health expenditure. Per capita this equates to one less death for every 12011 older adult and NZ$230.76 savings in health expenditure per older adult per annum.

Table 29: Potential economic 'savings' with reduced sedentary behaviour

Population attributable risk (PAR)		
Current MoH sedentary rate 16.90%		
Revised sedentary rate 12.00% as per N2O members		
Current PAR:	$\frac{.1690*(1.25-1)}{1+.1690*(1.25-1)}$	4.05%
Revised PAR:	$\frac{.1200*(1.25-1)}{1+.1200*(1.25-1)}$	2.91%
Reduction in mortality as a result of lower levels of sedentary behaviour		
Estimated reduction in deaths		
Current Physical inactivity deaths	1,901*4.05%	77
Revised Physical inactivity deaths	1,901*2.91%	55
Averted deaths		22
Per capita deaths	22/564,500	0.004%
Reduction in health expenditure as a result of lower levels of sedentary behaviour		
Estimated savings in health expenditure		
Current Physical inactivity expenditure	$5251.2mill * 4.05%	$212.67mill
Revised Physical inactivity expenditure	$5251.2mill * 2.91%	$152.81mill
Averted costs		$ 59.86mill
Per capita savings	$59.86mill / 564,500	$106.04

Table 30: Potential economic 'savings' with relative change in levels of physically inactive

Population attributable risk (PAR)		
Current MoH physically inactive 53.12% (i.e. not meeting RPA classification)		
Revised physical inactivity 40.70% (reduced by relative change in N2O sedentary behavior of 12.42 percentage point)		
Current PAR:	$\frac{.5312*(1.25-1)}{1+.5312*(1.25-1)}$	11.72%
Revised PAR:	$\frac{.4070*(1.25-1)}{1+.4070*(1.25-1)}$	9.24%
Reduction in mortality as a result of relatively better levels of sedentary behaviour		
Estimated reduction in deaths		
Current Physical inactivity deaths	1,901*11.72%	223
Revised Physical inactivity deaths	1,901*9.24%	176
Averted deaths		47
Per capita deaths	47/564,500	0.008%
Reduction in health expenditure as a result of relatively better levels of sedentary behaviour		
Estimated savings in health expenditure		
Current Physical inactivity expenditure	$5251.2mill * 11.72%	$615.44mill
Revised Physical inactivity expenditure	$5251.2mill * 9.24%	$485.21mill
Averted costs		$130.23mill
Per capita savings	$130.23mill/ 564,500	$230.70

Chapter 5: Discussion

The purpose of this study was to investigate whether there were health and economic benefits associated with older adults participating in the N2O. The outcome measures included PA, health status, health care service utilisation, health expenditure and falls. In an attempt to answer these questions, the evaluation process included comparisons between i) N2O members and the MoH pseudo control group, and ii) N2O member sub-groups, based on different levels of engagement in the N2O i.e. volume.

The discussion chapter has been divided into seven sections. Sections one through five discuss the dependent variables PA, health status, health care service utilisation, heath care expenditure and falls. Each of these sections has been subdivided into discussion on results for MoH comparatives (where available) and N2O sub-group comparisons. It is noted that qualitative results (as per section 4.3.6) have not been discussed separately but included, where relevant, within the discussion of the dependent variables. Furthermore, given the small number of N2O members in the 55-64yrs age group, the discussion has focused primarily on results for the 65-74yrs and 75+yrs age groups. The final section discusses the potential economic impact of engagement in the N2O, and how these compare to the costs of providing the N2O.

5.1. Physical Activity

National data comparison – MoH 2006/2007 New Zealand Health Survey:

Results of this study indicated that although there was no significant overall difference in the prevalence of RPA and sedentary behaviour between the N2O and MOH groups, the age-related increase in sedentary and decrease in RPA classification was significantly less for the N2O group. These results suggest that one of the effects of participating in the N2O was that N2O members, females in particular, were better able to maintain their PA with advancing age given the slower rate of decline in RPA and slower rate of increase in sedentary behaviour. The lower levels of sedentary behaviour found in N2O members should not be undervalued. Evidence indicates that time spent in sedentary behaviour is a significant health risk, being linked to poor health and early death, even after controlling for moderate-vigorous intensity PA

(Thorp, Owen, Neuhaus, & Dunstan, 2011). Hence in light of evidence which suggests that older adult sedentary behaviour can reach 8.9 hours/day (Matthews, et al., 2008), these relative 'improvements' in N2O members RPA and sedentary status may mean substantial health benefits for older adults.

Given that the N2O was a PA programme it was somewhat unexpected to find differences in RPA classification between N2O members and MoH were not statistically significant. Several reasons have been identified that may have had an impact on N2O members results. The first reason may lay with the 'nature' of PA and how it is measured and assessed. PA is both complex and multidimensional in nature because it can take place in a variety of contexts and modes (e.g., occupation, leisure, transport, incidentally) and over various periods of time i.e. minutes, hours, days and weeks. Hence there is some difficulty in assessing PA. These difficulties are amplified by the common practice of using questionnaires, particularly self-assessed questionnaires, which typically require that an individuals' own assessment of this complex and multidimensional activity be reduced to a series of closed-ended dichotomous responses. Examples of such questionnaires include the International Physical Activity questionnaire (IPAQ), Community Healthy Activities Model Program for Seniors (CHAMPS) and Rapid Assessment of Physical Activity (RAPA).

In addition to the type (and limited number) of questions used to assess PA, PA questions are typically subjective in nature and open to some individual interpretation. Respondents are frequently asked to make a judgement on whether an activity should be included, or excluded, as PA based on a non-quantifiable measure (e.g., intensity), as opposed to a quantifiable measure (e.g., percentage of heart rate). Furthermore respondents are also often asked to estimate the number of days per week PA was performed, its duration and overall intensity. For example Question 24 of the N2O members' questionnaire asked respondents to identify the "number of days in which you performed 30 minutes or more of moderate activity which made you breathe a little harder than normal". The use of these subjective questions mean that one person's perception about what is included or excluded as PA can be quite different from another's.

This subjectivity has several potential implications for N2O members. Firstly given their involvement in the N2O it would be reasonable to assume that N2O members' perceptions of PA are, and have been, shaped and influenced

by this involvement and how the N2O defines or represents PA. Having a 'standard' and much narrower measure of PA (i.e. defined by the structured activities of the N2O) may mean that incidental activity associated with daily living e.g., household chores, gardening etc. which may constitute much of the PA for the MOH data, are not recognised as or associated with PA for N2O members (Persson & While, 2012; Van Sluijs, et al., 2007).

In addition, while not quantified, it might also be assumed that N2O members' fitness (note 32.44% mentioned fitness as a benefit of the N2O) may be better than that of MoH respondents. As a consequence N2O members may not reach RPA criterion (i.e. perceived intensity levels) during incidental activities of daily living without making a conscientious effort. For N2O members their potential greater levels of physical fitness may mean that simple PA, such as walking, which may be considered moderate PA for many older adults, would only be considered light PA for N2O members (Costello, Kafchinski, Vrazel, & Sullivan, 2011). As a result of N2O members altered perceptions about PA, and their potentially better fitness, N2O members may underestimate their PA.

Involvement in the N2O may therefore mean that N2O members make more accurate PA assessments. Firstly because they have a standardised PA measure to compare with, and secondly because they are more attuned to their bodies and aware of how their bodies react to activity, and hence better able to distinguish and identify PA criterion.

N2O members may also make more accurate and rational PA assessments because they do not feel the 'social' pressure or expectations associated with the need to be physically active (i.e. they have made a conscientious decision to be physically active by becoming a N2O member). Evidence suggests that the ever increasing awareness and knowledge about health, and the need to be physically active, creates social expectations or norms about being physically active (Adams, et al., 2005). These social expectations or norms create social pressure (i.e. pressure to comply in order to attain social approval) which lead people to 'exaggerate' their PA. This was demonstrated by Van Sluijs et al., (2007) who estimated that between 18% and 36% of people asked about their PA overestimate their actual PA in self-report assessments, with higher levels being found amongst less active individuals and older adults.

The second potential reason for the lack of statistically significant difference in RPA of N2O members may lay with the methodological approach chosen for this study. The use of a non-randomised approach and self-selected volunteers may have increased selection and volunteer bias and meant that the N2O sample was not representative of the potential N2O population. N2O members that participated may be quite different from non-consenting N2O members, and perhaps even more different to the general older adult population. It could be that N2O members were more likely to be sedentary or have low levels of fitness and/or PA before joining the N2O programme. Hence while N2O members may not have reached RPA criterion at the time of data collection in this study, their level of PA has improved substantially over this time. This is supported somewhat by evidence that suggests while poor health is the most frequently cited barrier to older adults engaging in PA, a deterioration in health is also a strong motivator for many older adults to become more physically active (Schutzer & Graves, 2004). N2O members' motivation or reason for joining the N2O are an important consideration as these are also likely to affect the purpose of, or the value placed on engaging in PA. For example those that join to address a specific health condition will have a different agenda to those who join for social reasons, where PA may just be a 'by product' of N2O membership. These social aspects cannot be underestimated given nearly 30% of N2O members identified social outcomes as a benefit of the programme.

N2O intra group comparison

No statistically significant differences were found between the three dose classifications (either by age or gender). Probit regression analysis showed that only average monthly sessions attended had a statistically significant effect decreasing the probability of being classified as sedentary by 2.79%. These results indicate that while dose response score and period of membership have no measurable effect on RPA or sedentary behaviour, frequency of monthly sessions attended can. Hence it might be suggested that one of the key functions of providers of older adult PA programmes, such as the N2O, is to actively encourage their participants to attend classes more frequently and to continue this PA in the long-term in order to reap the rewards of being RPA and less sedentary.

Not surprisingly age was found to have a statistically significant effect on both RPA and sedentary classification. These findings were expected given the wealth of evidence on the effects of age on PA and sedentary behaviour.

5.2 Health Status

National data comparison – MoH 2006/2007 New Zealand Health Survey:

Generally those N2O members' aged 65-74yrs and 75+yrs had SF-36 scores that were statistically different from, and typically greater than, those of the MoH. In contrast both male and female N2O members aged 55-64yrs had, generally, lower scores than those of the MoH. N2O members also had lower scores than the MoH in role emotional (SFre) and mental health (SFmh) across all three age groups and both genders (the majority of which were statistically significant). It was also noted that N2O females typically had greater scores, across all SF-36 scale items and across all three age groups, than N2O males. From these results it can be surmised that N2O members rated their physical health better, but their mental health worse, than MoH respondents; N2O females rated their health (both physical and mental) better than N2O males, and that older N2O members rated their health better than younger N2O members.

While research indicates that PA does have a positive effect on both the physical and mental SF-36 scores (Kelley, Kelley, Hootman, & Jones, 2009; Lawlor & Hopker, 2001; Netz, Wu, Becker, & Tenenbaum, 2005; Rejeski & Mihalko, 2001; Ware Jr & Sherbourne, 1992) the effects of PA appear to be greatest in respect to the physical components. However research also indicates alterations in PA domains (i.e. type of PA, duration, intensity etc) can influence this effect. Acree, et al., (2006) for example, found significantly higher SF-36 scores in all eight scale items in those that reported higher PA. Adjusting for gender and hypertension SF-36 scores still remained significantly higher in physical function, role physical, bodily pain, vitality and social functioning in those that were physically active.

If this assumption is applied to N2O members one would expect that their SF-36 scores would be lower, compared to MoH, given N2O members were found to have lower RPA percentages. One would also expect that the scores of N2O females would be lower than N2O males as N2O females had the

lowest RPA percentages. However N2O members' physical health scores were, typically, greater than MoH scores, with this being more apparent for females than males. These higher N2O members' SF-36 scores may be an indication of the effect of involvement in the N2O and/or the type of PA it promotes (i.e. resistance exercise). This is somewhat supported by N2O members' comments which indicated strength as the number one benefit associated with the N2O (50.67%).

While the lower mental health scores of N2O members are consistent with research i.e. lower levels of PA result in lower SF-36 scores (Lawlor & Hopker, 2001; Netz, et al., 2005), the consistently low scores irrespective of age or gender were somewhat surprising. It was expected, given the number of N2O members that identified benefits which one might associate with mental health, that mental health scores might have been greater. For example 16.89% identified 'mental' aspects, 17.78% identified fun/enjoyment, and 28.89% identified social aspects as benefits of the N2O programme. A possible explanation for this may lay with N2O members being allowed to take their questionnaires home, and this privacy may have enhanced anonymity (as opposed to face to face as was the case for the MoH), and encouraged more honest responses. Evidence as to the effects of delivery mode on participants' responses suggest that respondents are more comfortable revealing physical and emotional deficits via mail than verbally (Buskirk & Stein, 2008). The design and methodology of this study may also mean that consenting N2O members might be quite different to the general older adult population. One possibility could be that N2O members were more likely to have poorer health (both mental and physical) before joining the N2O programme and while they have experienced significant improvements they have still not reached the levels of their MoH counterparts. While presence of health conditions indicates N2O members were not statistically different from MoH, evaluation as to the type, number, severity and period of health conditions were outside the scope of this study.

When changes in SF-36 scores between those aged 65-74yrs and 75+yrs were calculated N2O members were generally found to have smaller changes in scores between the advancing age groups than the MoH. Based on difference-in-differences calculations these changes were predominately positive i.e. declines in N2O members scores were smaller than those of the

MoH. From these results it could be inferred that the relatively better scores found in N2O members was a measure of the impact of the N2O and members participation. That is one of the effects of the programme was to slow the rate of decline in self-assessed health status associated with advancing age. The N2O appears to be more effective, in this respect, for physical health rather than mental health, and more so with females than males.

N2O intra group comparison

The only statistically significant difference in SF-36 scores between high and low dose N2O members were found in general health (SFgh) and role emotional (SFre). Regression analysis showed that dose response score and period of membership had a statistically significant effect on role emotional score (SFre), while average monthly sessions attended had a statistically significant effect on vitality score (SFv). Irrespective of dose category the highest scores were found in mental health items rather than physical health items.

The general lack of higher scores in high dose N2O members seem to contradict findings of other research which suggest that higher PA levels lead to higher SF-36 scores (Lawlor & Hopker, 2001; Netz, et al., 2005). Results of other New Zealand Health surveys (Ministry of Health, 1999) also indicate that those with greater durations of PA (expressed as hours of PA per week) had greater SF-36 scores, with statistically significant effects being found in physical function (SFpf), general health (SFgh) and vitality (SFv) between the highest and lowest durations of PA. They did however also note that direction of the effect was unclear i.e. uncertainty as to whether duration of PA influenced health status or was the result of it, which is also applicable to this study.

The lower SF-36 scores found in high dose N2O members may be explained in part by i) the potential 'ceiling' effect of PA on health status i.e. the longer you are a N2O member the less 'dramatic' the changes; ii) variations between individual N2O providers e.g., programme staff (there were several comments about how 'great' certain N2O provider staff were), or iii) the challenges and potential variability associated with using self-reported measures of PA and health status. What these findings do suggest is that PA and/or PA level are not the only factors that influence N2O members SF-36 scores.

5.3 Health care service utilisation

National data comparison – MoH 2006/2007 New Zealand Health Survey:

Generally N2O members had lower health care service usage than that of the MoH. Statistically significant differences in usage were found in hospital services for males aged 75+yrs (30.78 percentage point decrease); hospital use of females aged 55-64yrs and 65-74yrs (18.47 and 18.85 percentage point decrease respectively), and for medical specialist use in female aged 55-64yrs and 75+yrs (25.33 and 21.43 percentage point decrease respectively).

Interestingly while the MoH tended to have statistically significant increases in health care service use between successive age groups (more so in females than males), there were no significant differences found between successive age groups of N2O members. This might be partly explained by the prevalence of health conditions found in each of these age groups whereby prevalence rates in MoH generally increased across successive age groups (though not necessarily always statistically significant from N2O members). However prevalence of health conditions alone may not be the only explanation. The number, type, severity and length of health conditions may also be a contributing factor as it would be reasonable to assume that the number or severity of health conditions would increase usage. However these factors were outside the scope of this study and not included in the analysis.

Research as to the effects of PA on health care service utilisation is limited, with the majority of research being directed at expenditure. However of the research available there is some evidence to suggest that more active individuals have lower health care service utilisation. For example, Wang, et al., (2005), who researched retirees' utilisation of outpatient, emergency room and hospital health care services found significant differences in utilisation based on level of PA, irrespective of BMI classification. For example there was a 1.26 to 1.63 increase between moderately and sedentary active retirees' outpatient claims, and a 0.55 to 1.69 increase between very and moderately active retirees' outpatient claims. Sari (2009) also found that inactive individuals had 5.5% more GP visits, 12% more nurse visits and 13% more medical specialist visits than active individuals. Studies involving workplace initiatives have found similar results which indicate health care utilisation is significantly higher in sedentary employees compared to physically active employees (Baun,

Bernacki, & Tsai, 1986; Shephard, Corey, Renzland, & Cox, 1983). If this assumption is applied to N2O members (i.e. PA and/or PA level effect health care service utilisation) one would expect that their utilisation would be greater, compared to MoH, given N2O members were found to have lower RPA percentages. One would also expect that the health care service use for N2O females would be greater than N2O males given their lower RPA percentages. This was not evident in these results.

A possible reason for this may be in the design and methodology of this study. The use of both self-reported and retrospective data increases the likelihood that actual utilisation is misreported. Wallihan, Stump, & Callahan (1999) found that when self-report data was compared to electronic data, 24.1% of older adults failed to report a hospitalisation, 28.1% failed to report an emergency service use and 5.2% failed to report an ambulatory care use during the prior twelve months. Raina, Torrance, Rynard, Wong, & Woodward (2002) had similar results when self-reported data of seniors was compared to health professional billing and hospitalisation databases, findings indicating that seniors over-reported use of GPs, physiotherapists and chiropractors, but under-reported medical specialists.

While the lower level of health care service usage in N2O members might be an indication of the effects of the N2O programme the lack of comparable data makes any definitive conclusions somewhat problematic. This includes both the lack of comparable data for the MoH as to how PA or PA level (i.e. RPA or sedentary classification) influenced health care service utilisation, and the lack of baseline data for N2O members. Furthermore utilisation was assessed based on whether a service was or was not used. While this does provide an indicator, this measure has limited application. A much more valuable measure would be frequency of use. An attempt has been made to address this in the N2O sub-group evaluation, as discussed in the following section.

N2O intra group comparison

The only statistically significant difference in utilisation, based on dose categorisation, was found in frequency of use (i.e. the number of visits) of complementary services, whereby high dose N2O members had nearly three times the number of visits of low dose N2O members. Regression analysis also

found that dose response score had a statistically significant effect on utilisation frequency for complementary health services.

If the theory that greater PA results in less health care service utilisation (as per findings of Shephard, et al., 1983; Baun, et al., 1986; Wang, et al., 2005; Sari, 2009) is applied to N2O members sub-groups, high dose N2O members should have lower utilisation than low dose N2O members. Hence findings of this study would seem to contradict the previous research in this area.

A possible reason for the lack of statistically significant differences in utilisation between N2O members' dose categories may lay with the high prevalence rates of health conditions generally found in older adults. Over 80% of all N2O members had at least one health condition, with very little difference being found between prevalence rates based on age or gender. However as the regression analysis shows the existence of health conditions only had a statistically significant effect on GP utilisation and GP visit frequency. This suggests it may be more than just the mere presence of health conditions that affect utilisation. Such factors might be the type, duration, severity and number of health conditions. These findings highlight the difficulty associated with evaluating and measuring the effects of interventions in this population segment given their heterogeneous health.

In respect to the greater use of complementary services in high dose N2O member, regression analysis indicates that both an increase in dose response score and period of membership significant increased number of visits. This greater use may be explained, in part, by high dose N2O members having an increased susceptibility to injury because they are exposed to more PA 'opportunities' in which to sustain an injury. This is somewhat supported by findings that suggest the risk of sustaining an activity related injury increases with higher durations of weekly PA and with fitness levels (Hootman, et al., 2001).

5.4 Health care expenditure

N2O intra group comparison

Statistically significant differences in complementary health care service expenditure were found between all three N2O member age groups. Interestingly, with the exception of complementary health care services, older N2O members had lower health expenditure than younger N2O members. This

is in contrast to New Zealand's national statistics that indicate per capita health care expenditure increases significantly with age (Ministry of Health, 2006) i.e. per capita health expenditure at age 55-59yrs, 65-69yrs, 75-79yrs are NZ$1,700, NZ$3,150 and NZ$6,150 respectively. By age 85+ it is $13,600. If these national per capita health expenditure data are used as a comparative, N2O members mean total health expenditure are significantly less an all three age groups.

However direct comparison of N2O member results to national data are somewhat limited. This can be attributed to the differing purposes for which the MoH collect health expenditure data and the purpose that such data was collected for this study. The primary difference in such data collection being that the MoH's aim is to examine how expenditure varies across socio-economic groups and whether cost is a barrier to health care, whereas this study's aim was to determine (estimate) total health care expenditure for N2O members. Consequently national data has included all forms for health expenditure (personal and 'public') while N2O members have, in the main, only provided personal out of pocket expenditure, which represents only a small portion of total health expenditure. Hence while N2O members may have used other health care services, such as an emergency room or public hospitals, as a typically 'publicly funded' service these do not incur a 'cost' at an individual level and have been excluded (and or underestimated) in this study. Consequently while the preliminary data obtained in this study would suggest there is potential for the N2O to reduce health expenditure in older adults, only complementary health care services showed any significant differences. This is most likely due to it being the only health care service that is not complicated or influenced by different participants having differing levels of subsidy.

Personal out of pocket health expenditure of N2O members may also have been affected by health insurance, whereby health expenditure 'paid' or covered by private health insurance may not have been included. This may be significant given that 119 N2O members (53.13%) indicated they had some form of private health or medical insurance. This, together with the retrospective nature of the study (i.e. inaccurate recall), increases the likelihood that N2O members may have underestimated their health expenditure.

In respect to health expenditure and dose, high dose N2O members had significant greater health expenditure than low dose N2O members for medical

specialists and primary health care. These findings seem in contrast to other PA and health expenditure research which show that those that are active incur lower health care costs than those who are sedentary. Ackerman, et al., (2008), for example, found that older adults who attended one or more EnhanceFitness sessions per week had a reduction in health care expenditure of US$1,929 and US$1,784 in years one and two respectively compared to non-users. Andreyeva & Sturm (2006) found a 7% reduction in health care expenditure over a two year period between active and inactive individuals aged 54 to 69yrs, while Brown, et al., (2008), found costs were 26% higher in sedentary women compared to moderately active women. Yang, et al., (2011) study on the impact of PA medical care costs among the Japanese elderly also found that per capita medical care costs decreased with increasing levels of PA. These medical costs ranged from $US 827.3, US$711.1 and $US 702.0 per month for low, average and high levels of PA, respectively.

Given that regression analysis showed that none of the dose variables (i.e. score, period and attendance) had a statistically significant effect on total or individual health care expenditure items, this suggests that neither PA nor the N2O had an effect on N2O members' health expenditure. This might be explained by i) levels of health expenditure prior to joining the N2O i.e. high dose N2O member may have had greater health expenditure, which are unknown and ii) differences in health conditions i.e. type, number, severity, duration, which are also unknown.

5.5 Falls

N2O intra group comparison

Overall 19.11% of N2O members had experienced a fall in the previous 12 months, with fall rates being slightly greatest for N2O females. Of those that experienced a fall 13.95% of these resulted in severe injury, with female fallers having more severe falls. The greatest number of fallers was found in those aged 75+yrs, as was the greatest percentage of severe falls (more so in females than males).

While no comparative data was available, the Accident Compensation Corporation (2005) estimate that 55% of all hospitalised unintentional injuries are the result of falls in people aged 65 to 69yrs. For those aged 70 to 74yrs this percentage rises to 65%, reaching 85% in those aged 75yrs and older. A New

Zealand based prospective study by Campbell, et al., (1981) found that 34% of their older adults reported at least one fall over the 12 month reporting period, with fall rates generally increasing with age (25% for those aged 65-74yrs; 44.3% for those aged 75-79yrs; 42% for those aged 80-84yrs; 50% those aged 85-89yrs, 55.8% for those age 90-yrs; and 56% of those aged 90-99yrs). In respect to fall injuries and severity Tinetti, et al., (1988) found that 25% of falls lead to serious injury.

Results of this study indicate that N2O members had both significantly fewer falls (overall only 19.11%) and fewer severe falls (13.95%) compared to older adult data reported by the Accident Compensation Corporation (2005), Campbell, et al., (1981) and Tinetti, et al., (1988). However variances found between this study and the literature could also be attributed to study methodology, such as the retrospective nature of this study (which may limit data accuracy due to a lack of recall), and the sample used i.e. volunteers, small sample size, and the inclusion of those aged under 65 years (given the Accident Compensation Corporation data was for those 65+ in years). Nevertheless, the data obtained in this study would suggest some potential for the N2O to reduce falls rate and the number of falls resulting in severe injury in older adults.

There were no statistically significant differences found between falls, or severe falls, between the three N2O members' dose categories. Regression analysis also showed that neither dose response score, period of membership or average number of monthly sessions attended had a statistically significant effect on the probability of being a faller.

It is possible that the lack of a statistically significant difference between the three N2O members' sub-groups may be due to the nature of the N2O programme, given that strength/resistance training has been shown to have a positive effect on the risk of falling (Buchner, et al., 1997). This is also supported by 50.67% and 34.22% of N2O members commenting that strength and balance respectively were benefits associated with the N2O (a further 8% identified falls specifically). However the relationship between PA and falls risk is complex, and there is some evidence that suggests that those who are more active and fitter have a higher fall incident, because they are 'presented' with more occasions for falling (Campbell, et al., 1981). This was not supported by the findings of this study which showed a greater number of falls in low dose

N2O members, and that dose response score and average number of monthly sessions had a non-significant effect on reducing the probability of falling.

5.6 N2O cost and economic assessment

Cost of Illness calculations suggest that there are potentially economic benefits to be gained from older adults participating in the N2O. If older adults in New Zealand were to reduce their level of sedentary behaviour to that found among N2O members (being a 25% decrease from 16% to 12%), it was estimated that 22 deaths and $59.86million (0.01%) in older adult health expenditure could be averted per annum. Likewise if older New Zealand adults were able to maintain their PA with advancing age, as shown by N2O members lower relative sedentary rates (being a 23.34% or 12.42 percentage point, reduction in physical inactive levels), potentially 47 deaths and $130.23million (0.02%) in older adult health expenditure could be saved per annum.

Compared to international COI studies on physical inactivity (Katzmarzyk, Gledhill, & Shephard, 2000; Stephenson, et al., 2000) these averted deaths and health expenditure savings appear to be low. However it is difficult to make direct comparisons between such studies given the variability in COI components. For example the impact of different health care systems, different periods of data analysis, different definitions of physical inactivity, different prevalence rates and different relative risks for diseases associated with physical inactivity.

Per capita values suggest that the greatest economic impact would be achieved by having older adults maintain their PA with advancing age i.e. reducing the relative increase in rates of sedentary behaviour with advancing age. This option not only has the greater effects on mortality, but also the greater economic impact. Tobias & Roberts (2001) found similar results whereby keeping active people active (i.e. reducing relapse) had a 44% greater effect on mortality than getting ‘couch potatoes’ active. Furthermore given the many barriers associated with people engaging in PA moving people from sedentary is likely to be more challenging, particularly among older adults, compared to encouraging them to maintain an existing habit (Costello, et al., 2011).

While the COI figures suggest that the relative improvements found in N2O members sedentary behaviour could, if applied to all older adults in New

Zealand, potentially lead to health savings, costs of providing the N2O must also be taken into account. Results of the N2O cost analysis suggest that the minimum costs of providing the N2O were just over $10.00 per N2O attendee per session. Given that N2O members on average attend eight sessions per month (refer Table 14), this equates to approximately NZ$992 per N2O member for a 49 week period (two session per week times 49 weeks equals 98 sessions @ NZ$10.12 per session). Compared to the potential per annum capita health care expenditure savings (NZ$106.04 and NZ$230.70) these per capita costs suggest that the N2O is not 'cost effective'. It is also likely, given the variability found in N2O provider costs, and lack of consistency in financial data provided, that these N2O costs are under estimated. Consequently average attendee session costs may be greater.

These findings appear to be inconsistent with other economic evaluations of older adult PA programmes which indicate such programmes can produce savings in health care of between four to six times greater than the cost of the programme (Leveille, et al., 1998; Ackermann, et al., 2003). However COI models and evaluations also have limitations. The difficulty associated with measuring PA accurately means it is likely that the economic effects are underestimated because levels of physical inactivity are also underestimated. It is also likely that costs associated with physical inactivity are underestimated. This is due to both the difficulty in measuring PA, and therefore attributing effects accurately, as well as the difficulty in attributing costs to physical inactivity given 'health' is made up of many interlinked factors. Furthermore some health costs are themselves also difficult to accurately measure e.g., indirect costs such as disability due to illness, or costs to society such as lost productivity from family members caring for those in ill health.

The use of relative risk values, which is typically based on research in controlled environments, also means that these results may not translate into actual benefits at a population level. Likewise there is a fundamental assumption when using relative risk and population attributable risk that changing PA will result in changes in disease risk. However, health is affected by many factors, hence there is uncertainty as to what extent PA interventions can change ones risk for disease per se. Ideally, given these 'uncertainties', sensitivity analysis should also be performed. For example what happens if not all the population reduced their sedentary behaviour or if different relative risk

values were used e.g., specific health conditions, rather than mortality; or what happens if just those aged 75+yrs are included or only females were targeted; or age specific per capita health expenditure were used.

Chapter 6: Conclusion

This chapter reviews the key findings of this study and how these add to the literature on older adults' participation in PA, both in terms of the potential health benefits of engagement as well as the potential economic impact of these benefits.

This chapter is divided into three sections. The first section provides a brief summary and synthesis of the study results, the second section looks at the practical application of the study and its findings, and the third section makes recommendations for future research.

6.1 Summary and synthesis of results

A review of the literature revealed that PA, as a modifiable health risk factor, could provide a means in which to address older adult health. Epidemiological evidence shows that PA has both a primary and secondary health role (Carr, 2001; Fiatarone Singh, 2002; Paffenbarger Jr, et al., 1986). The literature also highlighted the economic benefits showing that PA can reduce health care service utilisation (Sari, 2009; Wang, et al., 2005) and health care expenditure (Ackermann, et al., 2008; Andreyeva & Sturm, 2006; W. J. Brown, et al., 2008; G. Yang, et al., 2011) and be 'cost effective' (Ackermann, et al., 2003; Leveille, et al., 1998).

The aim of this study was to investigate the benefits of the N2O, a PA programme designed specifically for older adults in New Zealand. The outcomes investigated included PA, health status, health care service utilisation, health expenditure and falls. Study results indicated N2O members' tended to have less sedentary behaviour and better self-rated health than the MoH pseudo control group, although this was only statistically significant in those aged 75+yr and female. Results also suggested that N2O members were 'relatively' better than the pseudo control group as they had smaller declines in RPA, small increases in sedentary behaviour and smaller decreases in health status scores between successive age groups. These 'relative' improvements suggest that involvement in the N2O helped participants maintain their PA and slow the rate of decline in self rated health with age. N2O members also had lower utilisation of health care services, less health expenditure and fewer falls and fewer severe falls than that found in the literature; however the statistical

significance of these differences were undetermined. Interestingly, changes in N2O members' level of engagement in the N2O (i.e. dose, length of membership and/or average month sessions attended) did not, in the main, produce statistically significant differences in the dependent variables, nor statistically significant linear or Probit regression analysis.

The preliminary economic assessment based on N2O members relative improvement in sedentary behaviour showed, based on a Cost of Illness model, that there could be up to 47 deaths averted and NZ$130.23million in older adult health expenditure saved. However a preliminary assessment as to the cost effectiveness of the N2O programme suggests that programme costs would outweigh the benefits to be gained from reductions in health expenditure.

6.2 Practical application

This study has not only investigated a health risk factor (i.e. PA), which is complex and multidimensional, but has done so in a population whose health is highly heterogeneous. These factors make it increasingly difficult to generalise findings to other older adults or to other older adult PA programmes. However, whilst these limitations are acknowledged, this study does enable a 'gradient of similarity' to be developed (i.e. relative similarity of participants and programmes, given the 'alikeness' of certain characteristic, context and conditions, and therefore comparative generalisation). This is particularly relevant to 'real world contexts' given the use of a community based programme, as opposed to an 'artificial' clinical trial, used in this study. In this respect, i.e. the real world, this investigation has provided information that may help in the development of older adult PA programmes which are better able to address the needs, motivations and barriers associated with older adults being physically active.

This study, like many others, also reinforces the idea that promoting and encouraging older adults to be, or become, physically active and less sedentary, is of value to both older adults and society. The cost of illness results also suggest that even small and subtle changes in PA and sedentary behaviour have the potential to lead to beneficial health effects through lower mortality and beneficial economic effects through reduced health expenditure.

6.3 Recommendations for future research

While this study has used a real world context, this has only provided a simple snapshot of N2O members, their PA and health outcomes. The methodology chosen for this study, while enabling indicative relationships between the N2O, PA and health outcomes to be identified, has lacked the rigour and precision required to make more definitive statements about causal relationships. To enable more definitive conclusions about these relationships to be made requires more in-depth quantitative analysis. This can only be achieved by using more robust research methods that include both control groups and pre testing of participants. Therefore it is recommended that future research use an experimental and probabilistic approach such as a randomised controlled trial.

Furthermore, given the nature of PA and the cumulative effects associated with being physically active, longitudinal or ongoing data collection should also be considered. Cohort studies following matched N2O and non N2O groups over several years could provide valuable insight and information. Such information would assist with the investigation of older adult health behaviour, how these behaviours change with advancing age, and how these changes affect health and health utilisation and/or expenditure in later life. Such information would provide an opportunity to identify the factors associated with the changing health 'needs' of older adults and assist in developing programmes that are effective in the promotion and adoption of health behaviours, including PA, in older adults.

Future research should also consider expanding analyses in respect to health conditions. As the results of this study indicate health conditions are likely to be a key factor in many of the health outcomes measured, additional information, beyond that of mere presence of a health condition is needed i.e. type, duration, severity and number of health conditions.

In respect to the economic impact of the N2O, analyses performed in this study have only provided an indicative measure, and hence need to be expanded and explored further. This should include performing sensitivity analysis using different relative risk values such as specific health conditions, specific age groups and specific gender. Likewise cost of illness models are not programme specific, therefore a more comprehensive evaluation of the N2O would enable specific economic effects of the N2O to be quantified.

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Appendix

Appendix 1: Example beginners N2O programme.

COMMENTS

NAME:

never2old active ageing programme

STRENGTH TRAINING
Phase 1 & 2

AUT UNIVERSITY

START DATE: MID FEBRUARY

REVIEW DATE: MID APRIL

EXERCISE	FOCUS	SETS/ REPS	WEIGHT			
1. LAT PULLDOWN	ARMS/SHOULDERS	2X10	15kg			
2. MODIFIED ABDOMINAL CURL	CORE	2X10				
3. SWISS BALL WALL SQUAT	LEGS/BOTTOM	2X10				
4. STANDING PIVOT DRILL	OBLIQUES	2X10	12kg			
(ARMS @ 90°)	(pin @ 23)					
5. SEATED CHEST PRESS	ARMS/CHEST	2x10				
6. BOX TOUCH & GO	LEGS & LOWER	2x10	12kg			
	BACK					

CARDIO INTERVALS 2–3 X 10 MINS	
TREADMILL OR BIKE (seat = 7)	
2 MIN WARM-UP @ MOD	REPEAT
30 SECS @ MOD HARD	
2 MINS @ MOD (cool down)	
BALANCE	
SOFT PAD STATIC BALANCE	
FEET ASTRIDE	
FEET TOGETHER	
ONE STEP FORWARD	
HEEL TO TOE	
(REPEAT WITH EYES CLOSED)	
WALK THE LINE hand claps	
FLEXIBILITY	
BROOMSTICK DRILL	
ACC STRETCHES	
GROUP COOL–DOWN	

Appendix 2: Example advanced N2O programme.

COMMENTS

NAME:

never2old active ageing programme

POWER TRAINING Phase 3

AUT UNIVERSITY

START DATE: JANUARY

REVIEW DATE: MARCH

`EXERCISE	FOCUS POWER	SETS-REPS	WEIGHT			
1. BOX SQUAT	Legs/bottom	2x 8				
Count 4 down and 1 up	4 COUNT DOWN 1COUNT UP					
2. SINGLE ARM BENCH PULL	Arms/back	2x 8				
	4 COUNT RELEASE 1COUNT PULL					
3. STATIC BEND	Lower back	2x 8				
	4 COUNT DOWN 1COUNT UP					
4. CABLE CHEST PRESS	Arms/chest	2x 8				
	4 COUNT RELEASE 1COUNT PRESS					
5. MODIFIED CRUNCHES	core	2x 8				
i. Hands on thighs, slide up to knees	4 COUNT DOWN 1COUNT UP					
ii. Hands by thighs, reach for toes						
iii. Arms across chest						
iv. Hands on head						
v. Arms outstretched overhead						

CARDIO— INTERVALS 2-3 X 10 MINS
TREADMILL OR BIKE
2 MIN WARM-UP @ MOD (REPEAT)
30 SECS @ MOD HARD (REPEAT)
2 MINS @ MOD
BALANCE
SQUAT ON SOFT PADS
WALKING LUNGES
FLEXIBILITY
BROOMSTICK DRILL
ACC STRETCHES
GROUP COOL-DOWN

Appendix 3: N2O provider information sheet.

N2O programme provider Information Sheet

Date Information Sheet Produced:

31 May 2010

Project Title. Economic implications of the Never 2 Old physical activity programme

An Invitation. Your organisation is invited to participate in a study entitled the "Economic implications of the Never 2 Old physical activity programme". Participation in this study is completely voluntary and your organisation may withdraw at any time without giving a reason or being disadvantaged in any manner. Any information provided up until the completion of data collection may also be withdrawn at any time.

What is the purpose of this research? The purpose of this study is to evaluate the economic impact of older adults participating in the Never 2 Old physical activity programme e.g., changes in health expenditure due to changes in functional ability, quality of life or number/severity of falls in older adults. This study is the final requirement of the researchers Masters of Health Science.

How was I chosen for this invitation? Your organisation has been identified as one of the sixteen Never 2 Old programme providers/centres located in Auckland. Only Never 2 Old programme providers/centres are eligible to take part in this study.

What will happen in this research? Three levels of assistance have been identified for this study, being financial information, administrative data, and access to Never 2 Old participants.

1) Financial information related to the operation of the Never 2 Old programme is required in order to determine direct, and where possible indirect costs associated with providing the programme. This information will be collected by questionnaire. All information will be voluntary and at the discretion of your

organisation. Information will be provided in a consolidated format with no individual or employee being separately identified/identifiable. It is envisaged that for most organisations this information will be accessible through their standard accounting or financial packages/information systems.

2) Administrative data relating to the running of the programme will be sought as part of evaluating the programmes effectiveness. This information will include, for example, records of attendance and participant performance/testing scores (on approval of participant). Such information will aid in determining dose responses.

3) Provide assistance in accessing Never 2 Old participants, including providing membership list and contact details, time table of Never 2 Old sessions, access to and scheduling of meetings with participants to disseminate study information and recruit participants.

Participation is voluntary, and at a level determined by your organisation. It is noted that this study does not involve repeat measures and is one off in nature.

What are the discomforts and risks? The researcher acknowledges that the nature of the information being gathered, particularly financial information, can be commercially sensitive. Likewise your Never 2 Old participant questionnaires do contain questions of a personal nature which may cause anxiety, discomfort or embarrassment for some participants.

How will these discomforts and risks be alleviated? All questions are voluntary and answered at your organisations (and Never 2 Old participants) discretion. All information supplied will remain confidential and anonymous, and reporting will be on consolidated information with no individual organisation, or participant, separately identified/identifiable.

What are the benefits? The results of this study may have benefits to you as a Never 2 Old programme provider/centre, your Never 2 Old programme participants, other older adults, and the broader health sector. These benefits may include:

- Knowledge of how Never 2 Old programme participants compare to other older adults in terms of levels of physical activity, functional ability and quality of life and health care expenditure.

- Providing additional information about the 'cost' effectiveness of the Never 2 Old programme which provides further rational for the continuation of the programme, data to promote the programme (and physical activity) to other older adults, and evidence to support wider funding and support.

- Other exercise and physical activity agencies (like SPARC) and funding providers (such as the Ministry of Health and Accident Compensation Corporation) will be better informed about the economic benefits of older adults engaging in physical activity, specifically the Never 2 Old programme. This may lead to more accessible (and subsidised) physical activity programmes which cater for older adults.

What compensation is available for injury or negligence? Risks associated with participation in this study are anticipated to be no more than those which would be encounter during a normal day. In the unlikely event of a Never 2 Old programme participant having a physical injury as a result participating in this study, rehabilitation and compensation for injury by accident may be available from the Accident Compensation Corporation, providing the incident details satisfy the requirements of the law and the Corporation's regulations.

How will my privacy protected? On consenting to participate in this study your organisations name will be replaced with an identification code. All data collected will be based on this identification code to protect your organisations privacy. Access to this data is only available to authorised study staff and will be password-protected computer and in locked storage facilities. Results will be presented in a consolidated manner and your organisation will not be identified. A confidentiality agreement will also be available. Similar practices will also be followed in regard to your Never 2 Old programme participants, and no personal participant information will be requested from your organisation without their prior written consent.

What are the costs of participating in this research? There are no financial costs associated with participating in this study. There is a time commitment

involved with the study, though all efforts will be made to keep this to a minimum, and at times that are the least disruptive and most convenient to your organisation and programme participants. Information will primarily be sent e-mail.

What opportunity do I have to consider this invitation? Your organisation will have one week to consider their participation in this study.

How do I agree to participate in this research? An authorised person will need to complete the attached Consent Form if your organisation wishes to participate in this study.

Will I receive feedback on the results of this research? If your organisation wishes, a summary of the results will be sent to your organisation at the completion of the study. No individual organisation or Never 2 Old programme participant will be identified/identifiable in the summary results.

What do I do if I have concerns about this research? Any concerns regarding the nature of this project should be notified in the first instance to the Researcher, Deborah MacRae, either via email **debmac02@aut.ac.nz**, or phone 921 9999, ext 7698.

Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, *madeline.banda@aut.ac.nz* , 921 9999 ext 8044.

Who do I contact for further information about this research?

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Approved by the Auckland University of Technology Ethics Committee on 6 August2010, AUTEC Reference number 10/158

Appendix 4: N2O members information sheet

N2O programme participant Information Sheet

Date Information Sheet Produced:

31 May 2010

Project Title. Economic implications of the Never 2 Old physical activity programme

An Invitation. You are invited to participate in a study entitled the "Economic implications of the Never 2 Old physical activity programme". Your participation in this study is completely voluntary and you may withdraw at any time without giving a reason or being disadvantaged in any manner. You may also withdraw any information you have provided at any time up until data collection is completed.

What is the purpose of this research? The purpose of this study is to determine what effect participation in the Never 2 Old physical activity programme has on participant's health and health status (e.g., functional ability, quality of life and number and severity of falls) and the consequential economic impact of these effects i.e. health expenditure. This study is the final requirement of the researchers Masters of Health Science.

How was I chosen for this invitation? Sixteen Never 2 Old programme providers/centres located in Auckland have been approached to participate in this study. Those providers/centres that agreed to participate provided a list of their Never 2 Old programme participants, from which you were identified. Only Never 2 Old programme participants are eligible to take part in this study.

What will happen in this research? You will be asked to complete a series of questionnaires relating to your physical activity, health status, quality of life and health care expenditure. The questionnaires will be sent to your home to be answered at a time convenient to yourself. It is anticipated that the questionnaires will take in total up to 40 minutes to complete. These

questionnaires will be completed only once and the study involves no physical testing.

What are the discomforts and risks? While there is no physical testing associated with this study the questionnaires do contain questions of a personal nature which may cause anxiety, discomfort or embarrassment for some participants.

How will these discomforts and risks be alleviated? All questions are voluntary and answered at your discretion. All information supplied by you will remain confidential and anonymous, and reporting will be on consolidated information with no individual information or participant separately identified/identifiable.

What are the benefits? The results of this study may have benefits to you as an individual, to other older adults, to Never 2 Old programme providers/centres and the broader health sector. These benefits may include:

- Knowledge of how Never 2 Old programme participants compare to other older adults in terms of levels of physical activity, functional ability and quality of life and health care expenditure.

- Providing Never 2 Old programme providers/centres with additional information about the 'cost' effectiveness of the Never 2 Old programme and provide an additional rational for the continuation of the programme (i.e. promotion to other older adults and funding support).

- Other exercise and physical activity agencies (like SPARC) and funding providers (such as the Ministry of Health and Accident Compensation Corporation) will be better informed about the economic benefits of older adults engaging in physical activity, specifically the Never 2 Old programme. This may lead to more accessible (and subsidised) physical activity programmes which cater for older adults.

What compensation is available for injury or negligence? Risks associated with participation in this study are anticipated to be no more than those which you would encounter during a normal day. In the unlikely event of a physical injury as a result participating in this study, rehabilitation and compensation for

injury by accident may be available from the Accident Compensation Corporation, providing the incident details satisfy the requirements of the law and the Corporation's regulations.

How will my privacy protected? On consenting to participate in this study your name will be replaced with an identification code. All data collected will be based on this identification code to protect your privacy. Access to this data is only available to this studies research staff and will be stored on a password-protected computer and in locked facilities. Results will be presented in a consolidated manner and you will not be identified.

What are the costs of participating in this research? There are no costs involved in the participation in this study, except your time commitment. All information will be sent via mail, postage paid return envelopes being supplied for your responses.

What opportunity do I have to consider this invitation? You will have one week to consider your participation in this study.

How do I agree to participate in this research? You will need to complete the attached Consent Form if you wish to participate in this study.

Will I receive feedback on the results of this research? If you wish, at the completion of the study you will be sent a summary of the results. No individuals will be identified in the summary results.

What do I do if I have concerns about this research? Any concerns regarding the nature of this project should be notified in the first instance to the Researcher, Deborah MacRae, either via email **debmac02@aut.ac.nz**, or phone 921 9999, ext 7698.

Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, *madeline.banda@aut.ac.nz* , 921 9999 ext 8044.

Who do I contact for further information about this research?

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Approved by the Auckland University of Technology Ethics Committee on 6 August 2010, AUTEC Reference number 10/158

Never 2 Old provider questionnaire.

INSTRUCTIONS:
Please answer the questions by circling the most appropriate number. For those questions that ask you to specify or clarify your answer please print your response on the lines provided.
If you are unsure about any question feel free to contact the researcher, Deborah MacRae at debmac02@aut.ac.nz, or on 09 921 9999 ext 7698.
When complete, please return the questionnaire in the envelope provided.

1. How long has your organisation been running the Never 2 Old programme?

   ……months……years

2. How many session/classes do you run per week?.....

3. How many Never 2 Old members do you have? [Circle one]

   1. 1-10
   2. 11-20
   3. 21-30
   4. 31-40
   5. 41-50
   6. 51 plus

4. How many employees/staff are involved in running the Never 2 Old programme?

   ……part-time……full-time

5. Using the table below please indicate the annual direct costs associated with running the Never 2 Old programme.

   Please indicate what 12 month period the costs below cover?

   From ……/…..…./20……. to ..…../..…../20……..

Never 2 Old programme costs:	Costs
Direct:	
Staff wages/salaries	$
Printing & photocopying	$
Promotion & marketing	$
Equipment purchases	$
Travel	$
Facility rental/hire age	$
Franchise fees	$
Staff training/education	$
Other? Please specify …….. …….. …….. …….. …….. …….. …….. …….. …….. …….. …….. ……..	

6. Are there any indirect costs associated with running the Never 2 Old programme?

For example is the Never 2 Old programme allocated a share of organisation or operational overheads such as power, phone, stationery and the like, or can such expenses be identified and appropriately apportioned.

If so please include them in the table below.

Never 2 Old programme costs:	Costs
Indirect:	
Please specify …….. …….. …….. …….. …….. …….. …….. …….. …….. …….. …….. …….. …….. …….. …….	

On behalf of the research team thank you for taking the time to complete this survey.

Appendix 6: N2O members' questionnaire

Never 2 Old participant questionnaire.

INSTRUCTIONS:
Please answer the questions by circling the most appropriate number. For those questions that ask you to specify or clarify your answer please print your response on the lines provided.
If you are unsure about any question feel free to contact the researcher, Deborah MacRae at debmac02@aut.ac.nz, or on 09 921 9999 ext 7698.
When complete, please return the questionnaire in the prepaid envelope provided.

DEMOGRAPHICS

1. You are? [Circle one]

    1. Male
    2. Female

2. Which of these age groups do you belong to? [Circle one]

    1. 55-64 years
    2. 65-74 years
    3. 75-84 years
    4. 85+ years

3. Which ethnic group or groups do you belong to? [Circle all relevant]

    1. New Zealand European
    2. Maori
    3. Pacific Island
    4. Asian
    5. Other, please specify ……..

4. Who else do you live with? [Circle all relevant]

    1. Husband or wife
    2. Partner or de facto
    3. Relative e.g., sister, son, mother in law, grandchild, niece
    4. Flat-mate or boarder

5. Live alone

5. What is your highest qualification? [Circle one]

1. No qualification
2. NZ School Certificate *or* National Certificate Level 1 *or* NCEA Level 1
3. NZ Sixth Form Certificate *or* National Certificate Level 2 *or* NCEA Level 2
4. NZ Higher School Certificate *or* Higher Leaving Certificate *or* NZ University Entrance
5. Bursary/Scholarship *or* National Certificate Level 3 *or* NCEA Level 3
6. Bachelors degree
7. Postgraduate certificate or diploma
8. Masters degree
9. PhD
10. Trade or technical certificate which took more than 3 months full-time study
11. Professional qualification, for example, ACA, teachers, nurses
12. Other [please specify]……..

6. What types of income do you currently receive? [Circle all relevant]

1. Wage/salary (paid employment)
2. NZ Superannuation
3. Working for Families (Family Support, In Work Payment, Family Tax Credit)
4. Unemployment benefit
5. Domestic purposes benefit
6. Sickness benefit
7. Invalid's benefit
8. Student allowance
9. Disability allowance
10. ACC (as income support, not reimbursement for health services)
11. Other government benefits (e.g., war pension)

12. None of the above

7. What is the total income that you yourself received from all income sources, before tax or anything was taken out of it, in the **last 12 months**?[Circle one]

    1. Less than $10,000
    2. $10,001 - $20,000
    3. $20,001 - $30,000
    4. $30,001 - $40,000
    5. $40,001 - $50,000
    6. $50,001 - $60,000
    7. $60,001 - $70,000
    8. $70,001 - $80,000
    9. $80,001 - $90,000
    10. $90,001 - $100,000
    11. $100,001 - $120,000
    12. $120,001 - $150,000
    13. $150,001 or more

8. Do you or anyone else who lives with you, own or partly own the dwelling (with or without a mortgage) [Circle one]

    1. Yes
    2. No

HEALTH CONDITIONS

9. Using the table below please indicate if you have any of these health conditions and if so the number of years that you have had the condition for.

	I have this health condition	Number of years I have had this condition
Cardio-vascular disease (i.e. coronary heart or artery disease, heart attack, angina, heart failure, stroke, atherosclerosis)	Yes No	
Diabetes	Yes No	
Asthma	Yes No	
COPD (i.e. chronic bronchitis, emphysema)	Yes No	
Osteoporosis	Yes No	
Arthritis (i.e. include gout, lupus and psoriatic arthritis, rheumatoid, osteoarthritis)	Yes No	
Cancer	Yes No	
Long-term mental health condition (e.g., Depression, Bipolar disorder, manic depression, Schizophrenia)	Yes No	
Chronic pain	Yes No	
High cholesterol	Yes No	
High blood pressure	Yes No	
Other? Please specify …….. …….. …….. …….. …….. ……..		

HEALTH SERVICE UTILISATION

The next question is about your use of health care services in New Zealand, and the different health care professionals you have seen about your mental, emotional or physical health in the **last 12 months**.

10. Using the table below please indicate the number of times in the **last 12 months** that you have seen any of these health professionals, and if so how long ago the last visit was.

	Number of times health professional seen in **last 12 months**	When was the last time you visited this health professional (please specify if weeks or months)
General practitioner (GP)/ Family Doctor		
Primary health care nurse (i.e. nurse at GP practice)		
Community support worker (e.g., diabetes support worker)		
Cultural worker such as kaumatua and taua		
Medical specialist (e.g., cardiologist, endocrinologist, neurologist) Please specify. …….. …….. …….. …….. …….. …….. …….. ……..		
Complementary or alternative health services e.g., massage, homeopath, acupuncturist, physiotherapist, chiropractor, osteopath) Please specify. …….. ……..		

11. The last time you saw a GP, what was it for? [Circle all relevant]

1. A long-term illness, chronic condition or disability
2. A short-term illness or temporary condition
3. An injury
4. A test or examination e.g., blood, urine, cervical
5. Immunisation or vaccination
6. Wound dressing or bandaging
7. A routine checkup or health advice
8. Advice on whether I needed to see another health care professional, e.g., a specialist doctor or a physiotherapist
9. Prescription/repeat prescription

   Please specify what this prescription was for……..
10. Something else

    Please specify ……

12. In the **last 12 months**, how many times have you got a prescription for yourself? [Circle one]

1. No prescriptions
2. One to two times
3. Three to five times
4. More than 5 times

13. In the **last 12 months**, have you yourself used a service at, or been admitted to, a hospital as a patient? This could have been for a physical or a mental health condition. [Circle one]

    1. Yes
    2. No

- If yes, how many times……

- If yes what services did you use? [Circle all relevant]

    1. Emergency Department
    2. An outpatients department, that is, a ward or clinic or specialist where you went as an outpatient
    3. Admitted for day treatment, that is, day surgery or medical care for which you had to stay in hospital for more than 3 hours but not overnight
    4. Admitted as an inpatient, that is, stayed as a patient overnight
    5. Other, please specify……

14. In the **last 12 months** have you had any falls?

    1. Yes
    2. No

- If yes, how many times have you fallen……
- If yes what type of injury, if any, did you suffer? [Circle all relevant]

    1. No injury
    2. Minor cuts and bruises
    3. Fracture
       Please specify the number of times……...
    4. Complications requiring hospitalisation
       Please specify the number of times……..……

HEALTH EXPENDITURE

15. Are you covered by any health or medical insurance scheme? [Circle one]

    1. Yes
    2. No

- If yes what type of health or medical insurance scheme is that? [Circle one]

    1. Comprehensive, covering day-to-day costs such as GP fees and pharmacy charges, as well as private hospital care
    2. Hospital only
    3. Other. Please specify……

16. Who pays for this health or medical insurance? [Circle one]

    1. Self or family members
    2. Partly self or family and partly employer
    3. Paid for by employer or employer of family member
    4. Paid for by some other person or agency

17. How much have you spent on the following health care services in the **last 12 months?**

	Health care expenditure in **last 12 months**
General practitioner (GP)/ Family Doctor	$
Primary health care nurse (i.e. nurse at GP practice)	$
Community support worker (e.g., diabetes support worker)	$
Cultural worker such as kaumatua and taua	$
Medical specialist (e.g., cardiologist, endocrinologist, neurologist) Please specify. …….. …….. …….. …….. …….. …….. ……..	
Complementary or alternative health services e.g., massage, homeopath, acupuncturist, physiotherapist, chiropractor, osteopath) Please specify. …….. …….. ……..	
Health/ medical insurance	$

PHYSICAL ACTIVITY (NZPAQ-SF)

The following questions relate to how much time you have spent being physically active in the **last 7 days.** Do not include activity undertaken today. Being 'active' means doing anything using your muscles, and includes activities at work or home, getting from place to place, as well as exercise, sport, recreation or leisure.

18. During the **last 7 days**, on how many days did you ***walk at a brisk pace*** – a brisk pace is a pace at which you are breathing harder than normal? This includes walking at work, walking to travel from place to place, and any other walking that you did solely for recreation, sport, exercise or leisure. Think only about walking done for at least 10 minutes at a time.

    ……..days per week

19. How much time did you typically spend walking at a brisk pace on each of those days?

    ……. hours ……minutes

20. During the **last 7 days**, on how many days did you do ***moderate*** physical activities? 'Moderate' activities make you breathe harder than normal, but only a little – for example carrying light loads or bicycling at a regular pace. Think only about those physical activities done for at least 10 minutes at a time. Do not include walking of any kind.

    ……..days per week

21. How much time did you typically spend on each of those days doing moderate physical activities?

    ……. hours ……minutes

22. During the **last 7 days**, on how many days did you do ***vigorous*** physical activities? 'Vigorous' activities make you breathe a lot harder than normal ('huff and puff') – for example heavy lifting, digging, aerobics, or fast bicycling. Think only about those physical activities done for at least 10 minutes at a time.

    ……..days per week

23. How much time did you typically spend on each of those days doing vigorous physical activities?

    ……. hours ……minutes

24. Thinking about all your activities over the **last 7 days** (including brisk walking), on how many days did you engage in:
    - at least 30 minutes of moderate activity (including brisk walking) that made you breathe a little harder than normal, ***OR***
    - at least 15 minutes of vigorous activity that made you breathe a lot harder than normal ('huff and puff')?

    ……..days per week

NEVER 2 OLD PROGRAMME

25. How long have you been participating in the Never 2 Old programme?

    ……..months and/or……years

26. On Average how many Never 2 Old classes or sessions do you attend in a month?

    ……classes per month

27. What is the distance (approximate kilometers) from home to your Never 2 Old centre?

    ……kilometers

28. What are the average monthly expenses associated with your participation in the Never 2 Old programme?

    Never 2 Old membership/class fees……

    Travel……

    Other (please specify)……

    ……..……

    ……..……

    ……..……

29. What **<u>health benefits</u>** have you experienced as a result of participating in the Never 2 Old programme? (these can be physical, mental or physiological, e.g., blood pressure has improved (decreased), leg strength has increased, have had less falls compared to previous years, or balance has improved).

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HEALTH STATUS (SF-36)

30. In general, would you say your health is? [Circle one]

    1. Excellent
    2. Very good
    3. Good
    4. Fair
    5. Poor

31. **Compared to one year ago**, how would you rate your health in general now? [Circle one]

    1. Much better now than one year ago
    2. Somewhat better than one year ago
    3. About the same as one year ago
    4. Somewhat worse than one year ago
    5. Much worse than one year ago

32. The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much? [Circle one number on each line]

	Yes, limited a lot	Yes, limited a little	No, not limited at all
Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports.	1	2	3
Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling or playing golf	1	2	3
Lifting or carrying groceries	1	2	3
Climbing several flights of stairs	1	2	3
Climbing one flight of stairs	1	2	3
Bending, kneeling or stooping	1	2	3
Walking more than a kilometer	1	2	3
Walking half a kilometer	1	2	3
Walking one hundred meters	1	2	3
Bathing, showering or dressing yourself	1	2	3

33. During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities as a result of your physical health? [Circle one number on each line]

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
Cut down on the amount of time you spent on work or other activities	1	2	3	4	5
Accomplished less than you would like	1	2	3	4	5
Were limited in the kind of work or other activities	1	2	3	4	5
Had difficulty performing the work or other activities (for example, it took extra effort)	1	2	3	4	5

34. During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)? [Circle one number on each line]

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
Cut down on the amount of time you spent on work or other activities	1	2	3	4	5
Accomplished less than you would like	1	2	3	4	5
Didn't do work or other activities as carefully as usual	1	2	3	4	5

35. During the **past 4 weeks**, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours or groups? [Circle one]

    1. Not at all
    2. Slightly
    3. Moderately
    4. Quite a bit
    5. Extremely

36. During the **past 4 weeks**, to what extent has your physical health or emotional problems interfered with your social activities (like visiting friend or relatives? [Circle one]

    1. Not at all
    2. Slightly
    3. Moderately
    4. Quite a bit
    5. Extremely

37. How much bodily pain have you had during the **past 4 weeks**? [Circle one]

    1. None
    2. Very mild
    3. Mild
    4. Moderate
    5. Severe
    6. Very severe

38. During the **past 4 weeks**, how much did pain interfere with your normal work (including both work outside the home and housework)? [Circle one]

    1. Not at all
    2. A little bit
    3 Moderately
    4. Quite a bit
    5. Extremely

39. The following questions are about how you feel and how things have been with you during the **past 4 weeks**. For each question please give the one answer that comes closest to the way you have been feeling. [Circle one number on each line]

How much of the time during the past 4 weeks…	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
Did you feel full of life?	1	2	3	4	5	6
Have you been very nervous?	1	2	3	4	5	6
Have you felt so down that nothing could cheer you up?	1	2	3	4	5	6
Have you felt calm and peaceful?	1	2	3	4	5	6
Did you have a lot of energy?	1	2	3	4	5	6
Have you felt downhearted and depressed?	1	2	3	4	5	6
Did you feel worn out?	1	2	3	4	5	6
Have you been a happy?	1	2	3	4	5	6
Did you feel tired?	1	2	3	4	5	6

40. How TRUE or FALSE are each of the following statements to you? [Circle one number on each line]

	Definitely true	Mostly true	Don't know	Mostly false	Definitely false
I seem to get sick a little easier than other people	1	2	3	4	5
I am as healthy as anybody I know	1	2	3	4	5
I expect my health to get worse	1	2	3	4	5
My health is excellent	1	2	3	4	5

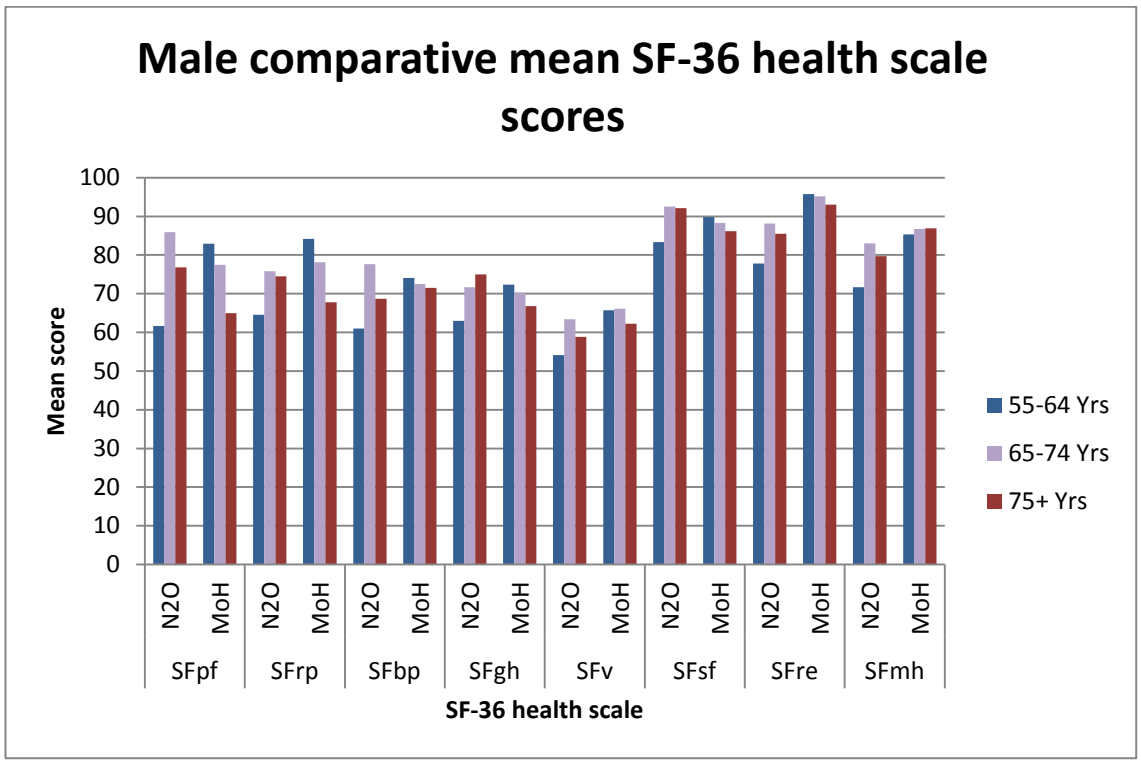
On behalf of the research team thank you for taking the time to complete this survey.

Appendix 7: Change in difference-in-differences for RPA and sedentary classification for males and females

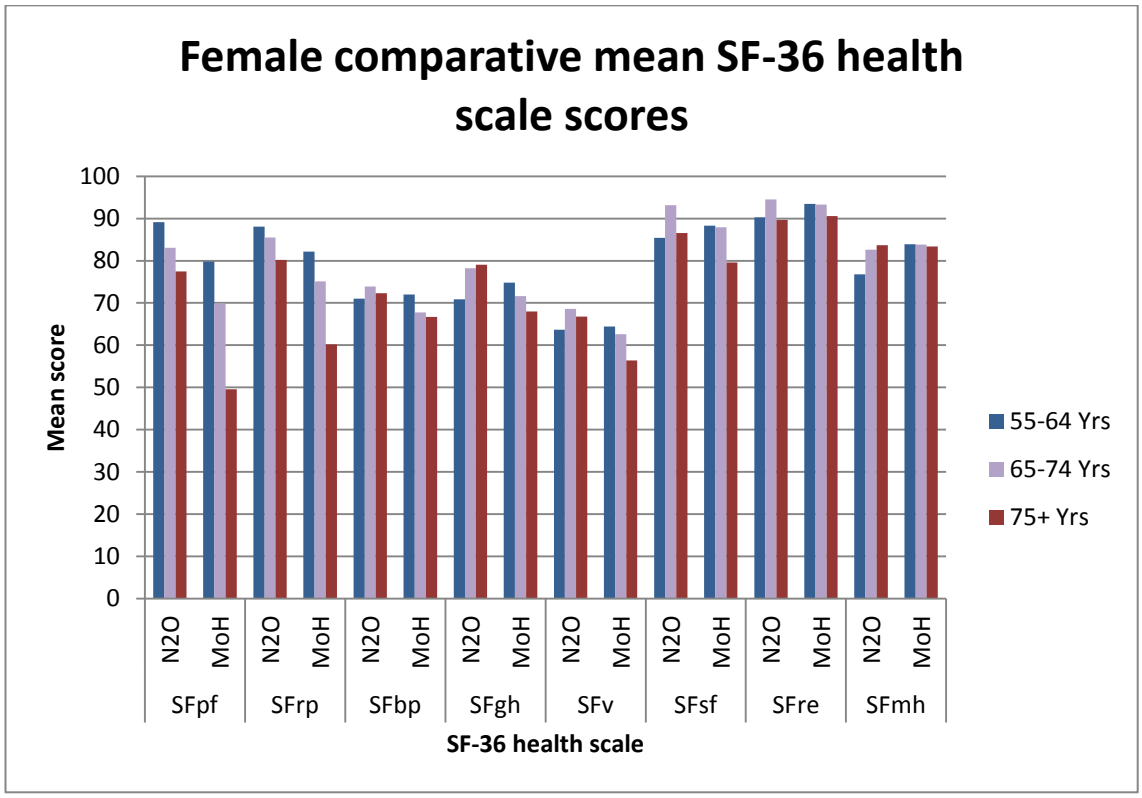
		MoH: Net percentage point change between successive age groups	N2O: Net percentage point change between successive age groups	Difference-in-differences percentage point between N2O and MoH*
Change in RPA:				
from 55-64yrs to 65-74yrs	M	1.00 increase	22.76 decrease	23.76 decrease
	F	5.90 decrease	0.76 increase	6.66 increase
from 65-74yrs to 75+yrs	M	10.00 decrease	11.47 decrease	1.47 increase
	F	18.00 decrease	4.55 decrease	13.45 increase
Total change	M	9.00 decrease	34.23 decrease	25.23 decrease
	F	23.90 decease	3.79 decrease	20.11 increase
Change in sedentary:				
from 55-64yrs to 65-74yrs	M	2.90 increase	4.88 increase	1.98 increase
	F	5.60 increase	4.17 increase	1.43 decrease
from 65-74yrs to 75+yrs	M	12.50 increase	5.93 increase	6.57 decrease
	F	20.60 increase	7.95 increase	12.65 decrease
Total change	M	15.40 increase	10.81 increase	4.59 decrease
	F	26.20 increase	12.12 increase	14.08 decrease

*Difference-in-differences calculated as (N20n – N2On-1) – (MoHn – MoH n-1)
RPA-regularly physically active
MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

Appendix 8: Male SF-36 health scale score comparatives by age group



Appendix 9: Female SF-36 health scale score comparatives by age group.



MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

Appendix 10: Males net change in mean SF-36 scores between successive age groups for N2O members and MoH.

Group	Age group (years)	SFpf	SFrp	SFbp	SFgh	SFv	SFsf	SFre	SFmh
MoH	55-64yrs to 65-74yrs	-5.40	-6.10	-1.60	-2.00	0.40	-1.50	-0.60	1.40
N2O		24.23	11.20	16.61	8.68	9.27	9.17	10.35	11.33
MoH	65-74yrs to 75+yrs	-12.50	-10.30	-1.00	-3.50	-3.90	-2.10	-2.20	0.20
N2O		-9.09	-1.30	-8.94	3.30	-4.58	-0.36	-2.65	-3.28

Appendix 11: Females net change in mean SF-36 scores between successive age groups for N2O members and MoH.

Group	Age group (years)	SFpf	SFrp	SFbp	SFgh	SFv	SFsf	SFre	SFmh
MoH	55-64yrs to 65-74yrs	-9.90	-7.10	-4.20	-3.20	-1.80	-0.40	-0.20	-0.10
N2O		-6.11	-2.60	2.93	7.32	4.97	7.77	4.23	5.83
MoH	65-74yrs to 75+yrs	-20.30	-14.90	-1.10	-3.60	-6.20	-8.3	-2.70	-0.40
N2O		-5.62	-5.28	-1.62	0.85	-1.84	-6.60	-4.81	-1.01

Note: negative indicates a decrease in scores between the successive age groups
MoH-Ministry of Health 2006/2007 New Zealand Health Survey
N2O-Never Too Old Active Aging programme study participants

Appendix 12: Regression analysis for SF-36 health scale scores by period of membership

	SFpf (SE)	SFrp (SE)	SFbp (SE)	SFgh (SE)	SFv (SE)	SFsf (SE)	SFre (SE)	SFmh (SE)	Total PH (SE)	Total MH (SE)
Age	-0.6253**	-0.4471	-0.0900	0.3000	-0.1416	-0.0027	-0.1481	0.0875	-0.2333	-0.0624
	(0.2142)	(0.2856)	(0.2659)	(0.2175)	(0.1792)	(0.2126)	(0.2098)	(0.1661)	(0.1700)	(0.1432)
Female	-0.3169	8.8314*	-0.6175	4.321	4.8633*	-1.067	5.3573*	1.3800	3.0926	2.4513
	(2.6241)	(3.4386)	(3.2553)	(2.6424)	(2.1780)	(2.573)	(2.5754)	(2.0195)	(2.0707)	(1.7534)
Pre-existing PA health conditions	-2.9195**	-3.2537	-4.8854	-3.4780**	-2.9628	-0.1615	-2.6041**	0.2216	-3.5128**	-1.7513
	(0.9613)	(1.2545)	(1.1897**)	(0.9602)	(0.7921**)	(0.9375)	(0.9341)	(0.7345)	(0.7583)	(0.6408)
Period of membership (months)	0.0708	-0.0903	-0.0361	0.0949	0.0134	-0.1234	-0.1566**	-0.0008	0.0169	-0.0233
	(0.0535)	(0.0696)	(0.0655)	(0.0531)	(0.0438)	(0.0517)	(0.0518)	(0.0406)	(0.0418)	(0.0353)
R2	0.0834	0.0952	0.0770	0.1039	0.1005	0.0297	0.1090	0.0034	0.1195	0.0521

SE – Standard error
**Significantly different from zero at 1% level using two-tailed *t* test.
*Significantly different from zero at 5% level using two-tailed *t* test.

Appendix 13: Regression analysis for SF-36 health scale scores by average monthly sessions attended

	SFpf (SE)	SFrp (SE)	SFbp (SE)	SFgh (SE)	SFv (SE)	SFsf (SE)	SFre (SE)	SFmh (SE)	Total PH (SE)	Total MH (SE)
Age	-0.5843**	-0.4808	-0.2674	0.2229	-0.1399	-0.2462	-0.4501*	-0.0461	-0.2975	-0.2156
	(0.2035)	(0.2715)	(0.2526)	(0.2072)	(0.1666)	(0.2067)	(0.2057)	(0.1578)	(01621)	(0.1385)
Female	-0.02218	8.4908*	-1.0084	4.5509	6.2215**	-0.9491	4.6050*	1.9707	3.5125*	3.1965
	(2.6332)	(3.4625)	(3.3035)	(2.6969)	(2.1698)	(2.6574)	(2.6765)	(2.0549)	(2.1105)	(1.8110)
Pre-existing PA health conditions	-3.0655**	-3.3347**	-5.1001**	-3.6175**	-2.7622**	-0.0262	-2.5859**	0.3141	-3.5516**	-1.6538*
	(0.9628)	(1.2581)	(1.2015)	(0.9784)	(0.7874)	(0.9626)	(0.9676)	(0.7457)	(0.7689)	(0.6587)
Average monthly sessions attended	-0.1022	0.2385	-0.0415	-0.0671	0.7815*	0.5108	-0.2024	0.4111	0.2099	0.3924
	(0.3997)	(0.5228)	(0.4969)	(0.4119)	(0.3313)	(0.3957)	(0.4032)	(0.3138)	(0.3188)	(0.2724)
R2	0.0826	0.0883	0.0832	0.0839	0.1318	0.0180	0.0801	0.0129	0.1317	0.0741

SE – Standard error
**Significantly different from zero at 1% level using two-tailed *t* test.
*Significantly different from zero at 5% level using two-tailed *t* test.

Appendix 14: Probit regression analysis for period of membership and health care service utilisation

	GP (SE)	Complementary health care services (SE)	Medical specialist (SE)	Hospital (SE)
Age	-0.0017	-0.0075*	-0.00458	0.0077
	(0.0017)	(0.0031)	(0.0059)	(0.0051)
Gender	-0.0352	0.0465	-0.0669	-0.0009
	(0.0211)	(0.0347)	(0.0706)	(0.0614)
Pre-existing PA	0.0265	-0.0035	0.0180	-0.0062
health conditions	(0.0109)	(0.0144)	(0.0255)	(0.0231)
Period of	0.0010	0.0001	0.0020	0.0006
membership	(0.0005)	(0.0007)	(0.0014)	(0.0012)
(months)				
Pseudo R2	0.1276	0.0816	0.0129	0.0130

Appendix 15: Probit regression analysis for average monthly sessions and health care service utilisation

	GP (SE)	Complementary health care services (SE)	Medical specialist (SE)	Hospital (SE)
Age	-0.0010	-0.0048	-0.0041	0.0082
	(0.0020)	(0.0028)	(0.0055)	(0.0048)
Gender	-0.0387	0.0626	-0.0688	0.0113
	(0.0242)	(0.0352)	(0.0709)	(0.0614)
Pre-existing PA	0.0278	-0.0007	0.0159	-0.0028
health conditions	(0.0122)	(0.0149)	(0.0254)	(0.0230)
Average monthly	0.0001	-0.0029	0.0001	0.0020
sessions	(0.0040)	(0.0061)	(0.0102)	(0.0095)
attended				
Pseudo R2	0.0794	0.0553	0.0066	0.0137

SE – Standard error
**Significantly different from zero at 1% level using two-tailed *t* test.
*Significantly different from zero at 5% level using two-tailed *t* test.

Appendix 16: Linear regression analysis for period of membership and frequency of health care service utilisation (visits)

	GP (SE)	Complementary health care services (SE)	Medical specialist (SE)	Hospital (SE)
Age	0.0004	0.1892	0.0253	-0.0245
	(0.0320)	(0.3815)	(0.0488)	(0.0241)
Gender	0.0736	5.3873	0.4760	-0.0584
	(0.3906)	(6.5607)	(0.5129)	(0.2917)
Pre-existing PA health conditions	0.7177**	-1.3542	-0.1967	0.0863
	(0.1426)	(2.2664)	(0.1878)	(0.1192)
Period of membership (months)	0.0045	0.2102*	-0.0005	-0.0004
	(0.0080)	(0.0929)	(0.0108)	(0.0060)
R2	0.1140	0.4641	0.0282	0.0377

Appendix 17: Linear regression analysis for average monthly sessions and frequency of health care service utilisation (visits)

	GP (SE)	Complementary health care services (SE)	Medical specialist (SE)	Hospital (SE)
Age	0.0259	0.2497	0.1728	-0.0317
	(0.0302)	(0.3105)	(0.0436)	(0.0202)
Gender	0.1765	5.4404	0.4186	-0.1021
	(0.3975)	(7.2723)	(0.5010)	(0.2788)
Pre-existing PA health conditions	0.7375**	-2.8257	-0.2157	0.0852
	(0.1444)	(2.6900)	(0.1884)	(0.1142)
Average monthly sessions attended	-0.0036	0.2779	-0.0569	-0.0456
	(0.0601)	(0.9985)	(0.0790)	(0.0434)
R2	0.1180	0.1821	0.0339	0.0715

SE – Standard error
**Significantly different from zero at 1% level using two-tailed *t* test.
*Significantly different from zero at 5% level using two-tailed *t* test.

Appendix 18: Regression analysis of period of membership on total health expenditure

	Total health expenditure (SE)	Primary care (SE)	Complementary (SE)	Medical specialist (SE)
Age	-11.3794	-3.1659	-4.1047	-16.5884
	(10.1940)	(1.9410)	(7.6433)	(29.8866)
Female	50.4496	-23.9900	34.8826	23.2149
	(124.3967)	(23.2034)	(92.7060)	(331.555)
Pre-existing	12.1344	17.4955*	19.3097	31.8577
PA Health	(47.1777)	(8.8174)	(30.8540)	(139.4969)
condition				
Period of	0.09244	1.0098	1.9688	0.9830
membership	(2.6114)	(0.4946)	(1.8530)	(6.5256)
(months)				
R2	0.0091	0.0534	0.0375	0.0070

Appendix 19: Regression analysis of average monthly sessions on total health expenditure

	Total health expenditure (SE)	Primary care (SE)	Complementary (SE)	Medical specialist (SE)
Age	-8.5919	-1.4102	-2.3527	-2.9378
	(9.6423)	(1.8872)	(6.1762)	(27.8136)
Female	-27.4414	-15.0239	33.3962	-132.6794
	(126.7303)	(23.9102)	(90.2985)	(319.399)
Pre-existing	-7.8553	17.5170*	13.3459	-33.4941
PA Health	(47.4848)	(9.0213)	(31.0572)	(141.6372)
condition				
Average	-34.1489	-2.0564	-3.0438	-38.9370
monthly	(19.0245)	(3.6535)	(12.8889)	(51.4866)
sessions				
R2	0.0192	0.0284	0.0152	0.0134

SE – Standard error
**Significantly different from zero at 1% level using two-tailed *t* test.
*Significantly different from zero at 5% level using two-tailed *t* test.