

**The need for a Pacific-specific low birth weight threshold:  
A comparison between Samoan babies born in Samoa with  
Samoan babies born in Aotearoa New Zealand**

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**The need for a Pacific-specific low birth weight threshold:  
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Samoan babies born in Aotearoa New Zealand**

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## **Attestation of Authorship**

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

Signature: \_\_\_\_\_

Date: \_\_\_\_\_



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(Mataio 19:26)

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## **Abstract**

The need for a Pacific-specific low birth weight threshold:  
A comparison between Samoan babies born in Samoa with Samoan babies born in  
Aotearoa New Zealand

There are ethnic differences in mean birth weight, proportions of low birth weight, and infant mortality in the multiethnic society of Aotearoa New Zealand. Low birth weight in particular is strongly associated with infant mortality. Pacific babies born in Aotearoa New Zealand have a 40% greater risk of death than the average Aotearoa New Zealand baby. This is despite Pacific babies having a lower prevalence of pre-term and low birth weight deliveries compared to other Aotearoa New Zealanders. Therefore, it is important to consider the definition of low birth weight and whether an ethnic specific low birth weight threshold would better identify at risk Pacific infants.

### **Study aims**

The aim of this project is to investigate whether the current standard measure used to determine low birth weight (LBW < 2500 grams, as determined by the 10th percentile of full term births) is appropriate for Pacific infants, or whether the suggested ethnic-specific low birth weight measure of < 3000 grams is more appropriate to identifying at risk Pacific infants (Sundborn, 2007).

### **Design and Methods**

An international comparative cross-sectional study design was employed to examine birth weight (such as LBW < 2500 grams and preterm births), relevant demographics (such as age, parity) and any other information available from birth records of the Samoan born population sample. The Samoan born sample consisted of 1,054 mothers and babies from birth registrations with the Samoan National Hospital – Tupua Tamasese Meaole (TTM) between the years January 2006–2007. The comparative sample of Aotearoa New Zealand born Samoans were sourced from the Pacific Island Families (PIF) birth cohort study and numbered 647 Samoan mothers and their babies.

## Results

Samoan TTM babies were on average 3,319 grams whereas Samoan PIF babies were on average 3,553 grams, some 234 grams heavier ( $p<0.001$ ). Similarly, the 10<sup>th</sup> percentile for full term births measured at 2,840 grams for Samoan TTM babies and 3,065 grams for Samoan PIF babies, a difference of 225 grams. Significant predictor variables of mean birth weight for the two sample populations were country ( $p<0.001$ ); maternal age categories ( $p<0.001$ ); parity ( $p<0.001$ ) and infant sex ( $p=0.02$ ). Mothers' smoking habits prior to conceiving were non-significant in predicting the mean birth weights of the two birth samples, although recall biases may have been responsible for this null finding. When all births were considered, Samoan PIF babies were more likely than those born in Samoa to be either preterm or low birth weight. Marital status as a main effect was the only significant predictor of either preterm or low birth weight outcomes, with PIF mothers in de facto relationships having higher odds of birthing either a preterm or low birth weight infant than TTM mothers

## Discussion

There were significant differences in the birth weight distributions and profiles of Samoan TTM babies and Samoan PIF babies even after adjusting for the limited number of predictor variables available. However, both Samoan samples had a 10<sup>th</sup> percentile birth weight threshold that was significantly higher than the 2,500 grams threshold currently used to identify at risk births. The presence of other individual, cultural, societal and environmental factors, which were unavailable to the present study, may offer valid explanations for the results obtained. The significant differences observed between the proportions of either preterm or low birth weight within the two samples suggest other important factors excluding those which were available may be at play. Such factors may include differences in delivery procedures. For example, Aotearoa New Zealand may have a greater tendency to induce earlier labour once at risk infants are identified, and to conduct higher risk deliveries.

## Conclusions

The mean birth weights and 10<sup>th</sup> percentile birth weights for the two Samoan sample populations were different; but both populations are significantly higher than the

average Aotearoa New Zealand birth weights and 10<sup>th</sup> percentile birth weights. The results suggest an ethnic specific low birth weight threshold of < 3000 grams may be more appropriate to identify at risk Samoan infants.



## **Chapter 1 - Introduction**

Since their arrival to Aotearoa New Zealand, Pacific people have made a significant contribution to the economic development, multiculturalism and social landscape of this country (Statistics New Zealand, 2002; Saisoa'a, 2008). Pacific people have and will continue to shape the face of Aotearoa New Zealand. One of the fastest growing populations in Aotearoa New Zealand, the Pacific population is projected to grow to 12 percent by 2051 (Gao, Paterson, Carter & Percival, 2006; Statistics New Zealand Census, 2001a). Despite the rapid growth of this population, Pacific people still lag behind their Aotearoa New Zealand European counterparts in health statistics (Statistics New Zealand, 2002). This has motivated research into conditions that afflict Pacific populations such as diabetes (Sundborn et al., 2007), obesity, and cardiovascular heart disease (Ministry of Health, 2001a; Sundborn et al., 2008). However, health disparities between Pacific and European populations continue to exist. Greater insight into these disparities may come about from the early examination of Pacific maternal health and infant health, particularly pre-pregnancy and during foetal development. As such, the current research hopes to add to the existing body of knowledge on Pacific maternal and infant health. The following research is an exploration of Samoan birth weights, comparing the birth weights of Samoan infants born in Samoa with Samoan infants born in Aotearoa New Zealand. In this regard, this research is unique in comparing Samoan birth samples from both Samoa and Aotearoa New Zealand.

Birth weight is a significant predictor of infant survival within the first year of life. It is also linked to child development and later adult onset of morbidity. Low birth weight in particular has been dubbed as the most powerful indicator of infant survival and mortality. Despite recent debates as to the relevance and predictability of low birth weight as a measure of at risk infants, low birth weight continues to be used by epidemiologists and public health researchers worldwide to identify these vulnerable populations. Under this criterion, babies who are identified as being of low birth weight are immediately given specialist medical care such as incubation and 24 hour

medical care and monitoring within the Neonatal intensive care unit (NICU); a medical procedure proven to increase the survival chances of an infant.

In Aotearoa New Zealand, Pacific infants are significantly heavier than their European counterparts. It is then assumed that Pacific infants' chances of survival are more favourable than their European counterparts under the current low birth weight threshold of 2500 grams. This assumption is at odds with the statistic that Pacific infants have a 40% increased risk of dying during infancy, a paradoxical finding considering Pacific infants are rarely deemed as being low birth weight (only 4.5 per 100 live singleton births are low birth weight compared to the national rate of 6.3 per 100) (Ministry of Health & Ministry of Pacific Island Affairs, 2004). Furthermore, Aotearoa New Zealand health officials have categorically rejected the notion that low birth weight contributes to the pronounced estimates of infant mortality for this population (Ministry of Health & Ministry of Pacific Island Affairs, 2004). This dismissal of the importance of low birth weight is a result of Pacific infants being consistently above the absolute threshold of 2500 grams. The question that remains then is what factors contribute to the high infant mortality rates experienced by Pacific infants if low birth weight is not a significant factor? The current study proposes a more appropriate low birth weight threshold may better identify at risk Pacific infants who, under the current low birth weight measure, will never be identified as high risk infants needing specialist medical attention.

## **1.1 Outline of the thesis**

Below is an outline of the various Chapters of this thesis.

### **1.1.1 Literature Review**

The purpose of the literature review in chapter two is to provide a background to the topic of general investigation in this thesis: birth weight and more specifically, low birth weight of Samoan infants. This chapter is divided into five sections. The first section provides a historical background of Pacific migration to Aotearoa New Zealand so as to contextualise the demographic and social characteristics of both the broader

Pacific population, and more specifically the Samoan population in Aotearoa New Zealand. The second section describes the demographic and social characteristics of the Samoan population residing in Samoa. The third section will describe, compare and contrast the health characteristics of the Samoans in Aotearoa New Zealand with Samoans in Samoa. The fourth section discusses the establishment, rationale, and use of the low birth weight measure while examining other related issues. The fifth section will assess Pacific and Samoan birth weight information, making a case for the investigation and comparative assessment of Samoan birth weights for Samoan populations in Aotearoa New Zealand and Samoa.

### **1.1.2 Study aims and Objectives**

Chapter three states the study aim, research statement and objectives of the current study.

### **1.1.3 Methods**

The focus of chapter four is to provide the reader with a description of the research methods that were employed in the current study. Initially the chapter is formatted as a quantitative piece, describing the target population, design and inclusion/exclusion criteria. However, the chapter also examines the writer's experiences of research in Samoa. The narrative account describing the procedures of gaining data in Samoa is done to encapsulate the need for culturally apt approaches when conducting research in Samoa. The chapter concludes by providing a detailed account of the two Samoan populations of interest, the statistical methods employed for data analysis and ethics approval obtained for the inclusion of both birth population samples, the Samoa TTM and PIF study respectively.

### **1.1.4 Results**

Chapter five presents the research findings. The results obtained for test of association between various maternal and infant characteristics that were available provide the descriptive statistics for our two Samoan birth samples. Similar tests of association provide the level of significance of preterm and low birth weight infants within the two

population samples. Multivariable results for test of association between the mean birth weights of the two Samoan birth samples are then given. Similarly, the results of predictor variables (as main effects and/or interactions with these main effects) of these mean birth weights are also investigated and reported. Finally, the multivariable results exploring the variability of low birth weight and preterm patterns between the two sample populations are also investigated and reported with predictor variables (as main effects and/or interactions with these main effects) for the birth outcomes also given.

### **1.1.5 Discussion**

Chapter six discusses several points of interest found in the (data, research, etc) and the implications on the future health outcomes of the population of interest. In the same way, lessons from Samoa offer insight into how data can be successfully obtained when conducted within a culturally appropriate way. Moreover, opportunities for the improvement of the current study are offered by highlighting the study's strengths and weaknesses.

### **1.1.6 Conclusions and recommendations**

Finally, chapter seven states the conclusions drawn from the current study's findings. Furthermore, recommendations are made based on the findings and conclusions of the previous sections.

## **Chapter 2 - Literature Review**

Chapter 2 provides a review of the literature around the thesis topic: birth weight and more specifically, low birth weight of Samoan infants. This chapter is divided into five sections. Section 2.1 begins with a historical background of Pacific migration to Aotearoa New Zealand; this section contextualises the demographic and social characteristics of both the broader Pacific population, and more specifically the Samoan population in Aotearoa New Zealand. The second section (2.2) describes similar demographic and social characteristics of the Samoan population residing in Samoa (known as Western Samoa prior to 1997). The third section (2.3) will describe, compare and contrast the health characteristics of the Samoans in Aotearoa New Zealand with Samoans in Samoa. The fourth section (2.4) discusses the establishment, rationale, and use of the low birth weight measure while examining other related issues. The fifth section (2.5) will assess Pacific and Samoan birth weight information, making a case for the investigation and comparative assessment of Samoan birth weights for Samoan populations in Aotearoa New Zealand and Samoa.

## **2.1 Pacific and Samoan population in New Zealand**

### **2.1.1 Early Pacific migration to Aotearoa New Zealand**

Pacific people have a long history of immigration to Aotearoa New Zealand. The first wave of Pacific migrants to arrive came from the Eastern Pacific region some 20,000 years ago. They would be known as Tāngata whenua (literally, people of the land); the first people to settle and establish themselves in Aotearoa New Zealand (Macpherson, Spoonley & Anae, 2001). Three more groups of Pacific migrants were to follow, each arriving at separate time intervals, with each arrival bringing a new group of diversely skilled individuals (Macpherson et al., 2001; Macpherson, 2004). The first of the three groups arrived early 1850s and consisted mainly of missionaries, trainee teachers, whalers and sailors. Most of this group settled and made Aotearoa New Zealand their home, while some opted to return to warmer shores (Macpherson et al., 2001). The next group arrived early 1940s to make Aotearoa New Zealand their home. This group consisted of soldiers who served alongside the Aotearoa New Zealand armed forces, and also the families and colleagues of Aotearoa New Zealand civil servants who served in territories in the Pacific. And finally the largest and most recent group of Pacific migrants arrived in the 1960s and 1970s (Macpherson et al., 2001) and they would experience the good, the bad and the ugly of Aotearoa New Zealand's varying economy, government and public perception (Krishnan, Schoeffel & Warren, 1994). The experiences of this most recent wave of Pacific migrants to Aotearoa New Zealand are central to providing the context for this section and the overall thesis topic.

### **2.1.2 Pacific migration to Aotearoa New Zealand: Labour for industry and manufacture**

Pacific people migrated in large numbers to Aotearoa New Zealand following the Second World War amidst the 1950s global industrialisation which generated a plethora of job opportunities in the manufacturing and service sectors (Krishnan et al., 1994; Wright & Hornblow, 2008). Pacific migrants flocked to urban city centres to fill acute labour shortages, providing the much needed workforce for Aotearoa New Zealand's growing economy (Krishnan et al., 1994; Macpherson et al., 2004).

Concurrently, the Aotearoa New Zealand government liberalised strict immigration policies to attract more overseas workers, further facilitating the migration of Pacific people (Krishnan et al., 1994; Wright & Hornblow, 2008). In addition, migrants who had already established themselves within Aotearoa New Zealand would act as 'transnational kinship networks' recruiting family members to migrate and take advantage of the surplus work opportunities, a practice encouraged and supported by individual Aotearoa New Zealand employers (Krishnan et al., 1994). Coincidentally their arrival was closely followed by (mid) 1970s global oil crisis which saw a sudden economic downturn in Aotearoa New Zealand's once booming economy (Krishnan et al., 1994). This meant rising unemployment which created competition for scarce work opportunities. This, and the subsequent events that followed, marked a significant period in the history of Pacific people migrating to Aotearoa New Zealand. More importantly the recession would drastically change the Aotearoa New Zealand government and public perception of Pacific people and their immigration (Appleyard & Stahl, 1995; Krishnan et al., 1994; Spoonley, 1990; Wright & Hornblow, 2008; Stahl & Appleyard, 2007).

As a direct consequence, Pacific migrants were no longer so welcome in Aotearoa New Zealand's declining economy (Krishnan et al., 1994; Wright & Hornblow, 2008). Instead the once relaxed immigration policies which allowed the free flow of Pacific migrants into Aotearoa New Zealand were quickly tightened to restrict their entry (Appleyard & Stahl, 1995; Krishnan et al., 1994). Similarly their presence further incited rage and resentment from their western counterparts who blamed Pacific migrants for the lack of job opportunities, or more specifically, for stealing New Zealanders' jobs (Appleyard & Stahl, 1995; Krishnan et al., 1994; Spoonley, 1990). This grossly misconstrued public perception of Pacific people was reinforced by racist campaigns supported by the state (government) (Appleyard & Stahl, 1995; Krishnan et al., 1994; Spoonley, 1990). There were media depictions on TV, which blatantly portrayed Pacific people as not only job takers, but also as violent criminals (Appleyard & Stahl, 1995; Krishnan et al., 1994; Spoonley, 1990). This ignited the era of dawn raids. Police and immigration officials carried out at random, raids and searches of Pacific people's homes looking for 'overstayers,' that is Pacific people who did not have proper visa permits (Appleyard &

Stahl, 1995; Krishnan et al., 1994; Spoonley, 1990; Stahl & Appleyard, 2007; Wright & Hornblow, 2008). These events would be a defining feature in the development and implementation of stringent immigration policies in the years to follow, restricting the entry of various Pacific Island nations into Aotearoa New Zealand.

Illustrative of the hardened attitudes to Pacific migration is the 1991 Immigration Amendment Act, where potential immigrants were allocated 'points' for desirable characteristics such as level of education, business or technical acumen/skills and financial security (Beaglehole, 2009; Trlin & Watts, 2004; Wright & Hornblow, 2008). Pacific migrants were least likely to be regarded as desirable on this points system. As such, Pacific migration to Aotearoa New Zealand has been characterised by Aotearoa New Zealand's need for labour as this was their major utility in the Aotearoa New Zealand economy. This migrant origin acts as a backdrop to health and education, for successive Pacific populations born in Aotearoa New Zealand.

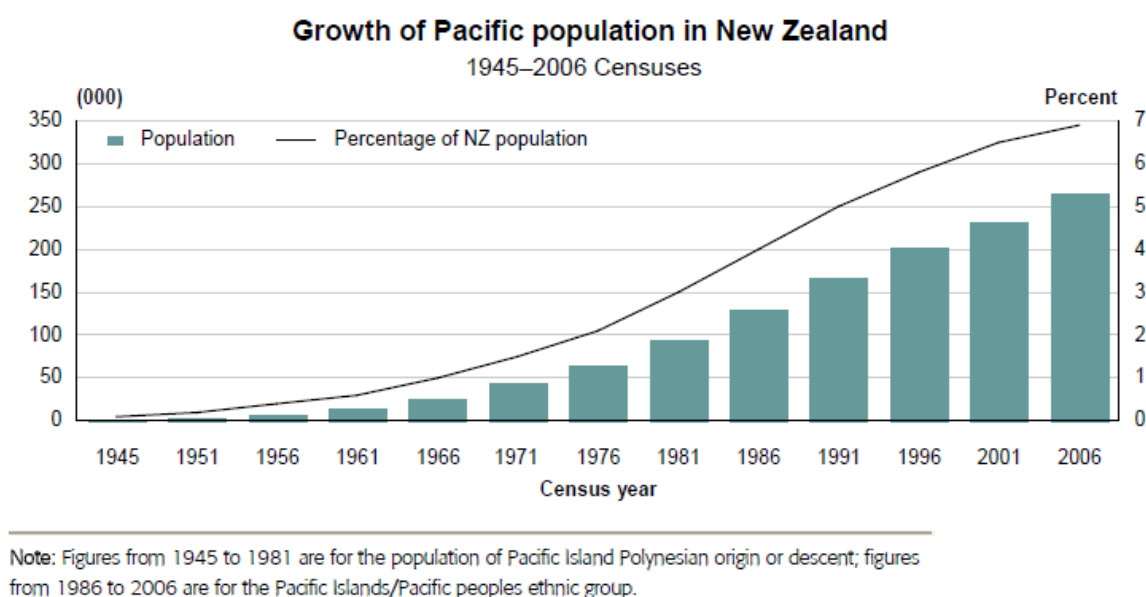
### **2.1.3 Demographics of Pacific people in Aotearoa New Zealand**

#### **2.1.3.1 Population growth**

The Pacific Island population is one of the fastest growing populations in Aotearoa New Zealand and is projected to grow to 12% of the Aotearoa New Zealand population by the year 2051 (Gao, Paterson, Carter & Percival, 2006; Statistics New Zealand, 2001a). During the 1960s and 1970s the main cause of population growth was migration. However, in the last two decades, the rapid growth of this collective population can largely be attributed to a high rate of natural increase (Cook, Didham & Khawaja, 2001; Statistics New Zealand, 2010). Natural increase is a phenomenon that occurs within a population when the number of births exceeds the number of deaths (Cook et al., 2001; Statistics New Zealand, 2010). Synonymous is the Pacific experience whereby the Aotearoa New Zealand Pacific population are experiencing higher fertility rates compared to their Aotearoa New Zealand counterparts. Pacific women on average have three births, one more than their Aotearoa New Zealand counterparts who on average have two (Statistics New Zealand, 2010). Furthermore, the Pacific population is youthful with a median age of 21.1 years, considerably lower than the general Aotearoa New Zealand median of 35.9 years. The Pacific population also has



an associated crude death rate of 3.2 deaths per 1,000 per year, lower than the general Aotearoa New Zealand rate of 6.8 deaths per 1,000 per year (Statistics New Zealand, 2010), which is a direct consequence of having a younger population. All these factors combined with the increase in the number of inter-ethnic unions and mobility, have collectively contributed to the continued growth of the Pacific population (Statistics New Zealand, 2010). Figure 2.1 illustrates the growth of the Pacific population in Aotearoa New Zealand from 1945 – 2001.



Source: Statistics New Zealand and Ministry of Pacific Island Affairs, 2010

**Figure 2.1.** Bar graph superimposed with growth chart shows the growth of Pacific population in New Zealand for the 1945 census year through to the 2006 census year.

In 2006 the Pacific Island population in Aotearoa New Zealand was numbered at 265,974; accounting for 6.9% of the total population (Statistics New Zealand, 2006, Statistics New Zealand & Ministry of Pacific Island Affairs, 2010). The Pacific population in Aotearoa New Zealand consists of six major Pacific ethnic groups, and are listed in ascending order of size in Table 2.1. The four largest groups: Samoa (49%), Cook Island (22%), Tonga (19%) and Niue (9%) combined, account for 98% of the total Aotearoa New Zealand Pacific population (Sundborn, 2010)

**Table 2.1.***Size of main Pacific ethnic groups in New Zealand in 2006*

Country	Usual resident population in NZ, 2006 Census
Samoa	131, 103
Cook Islands	58,008
Tonga	50,481
Niue	22,476
Fiji	9,864
Tokelau	6,822

*Source:* Statistics New Zealand and Ministry of Pacific Island Affairs, 2010

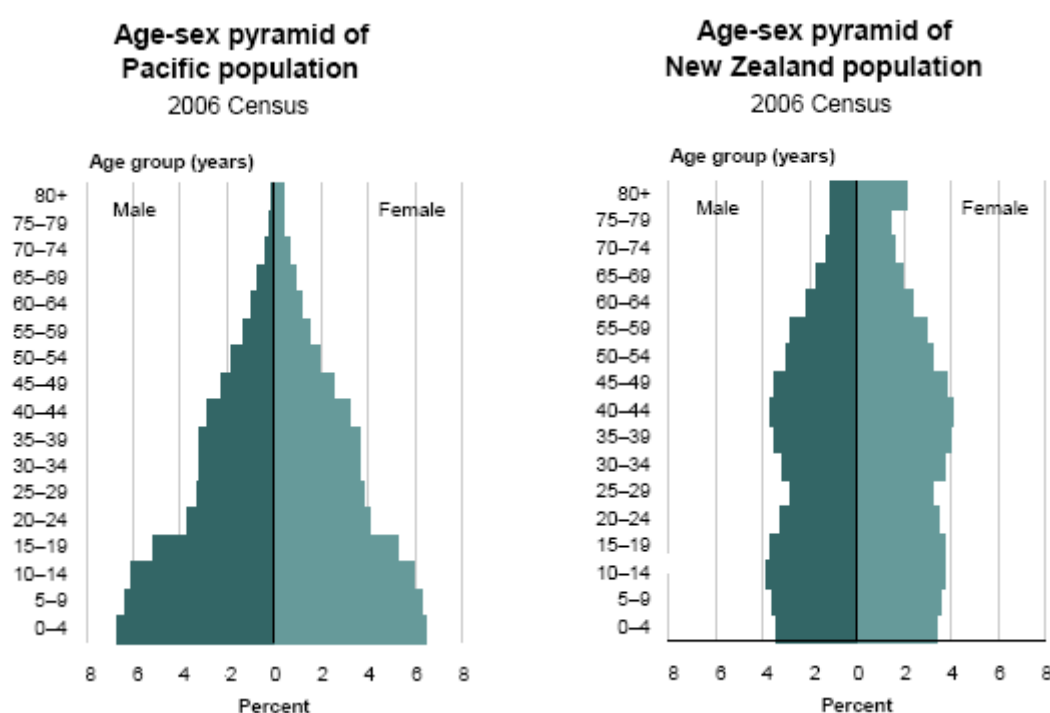
Samoans constitute the largest Pacific ethnic group in Aotearoa New Zealand with a reported number of 131,103 Samoan people representing 49% (almost half) of the total Pacific population (Cook et al., 2001; Statistics New Zealand, 2001b, 2007; Statistics New Zealand & Ministry of Pacific Island Affairs, 2010). The Samoan population have experienced a population growth of 98% between the years 1986 and 2006, a total of 64,800 people (Statistics New Zealand & Ministry of Pacific Island Affairs, 2010). The total Aotearoa New Zealand population growth for the same period was 23.4%. In 2006, 77,247 Samoans or 60% of the total Samoan population were Aotearoa New Zealand born (Statistics New Zealand, 2007). Being significantly larger than all the other Pacific ethnic groups in Aotearoa New Zealand, the Samoan population has a greater impact on the overall Pacific population profile. Although distinct differences exist between each (and within each) of the Pacific ethnic groups, it is the Samoan population that tends to largely reflect the total Pacific population in Aotearoa New Zealand (Statistics New Zealand & Ministry of Pacific Island Affairs, 2010).

### **2.1.3.2 Gender**

In 2006 there were 130,327 (49%) Pacific males and 135,647 (51%) Pacific females in Aotearoa New Zealand. The reverse is true for national figures whereby males account for 51% and females 49% of the general Aotearoa New Zealand population as depicted in Figure 2.2 (Statistics New Zealand & Ministry of Pacific Island Affairs, 2010). This

slight difference in the gender distribution is due to the different age structures seen earlier, and recognising that females have a longer life expectancy than their male counterparts.

The Samoan gender distribution mirrored that seen from the Pacific group as a whole. In 2006, females constituted slightly more than half of the total Samoan population in Aotearoa New Zealand, numbering 66,863 (51%), while males numbered 64,240 (49%). Figure 2.3 depicts the age-sex structure of the Samoan population in the 2006 census (Statistics New Zealand, 2007).



Source: Statistics New Zealand and Ministry of Pacific Island Affairs, 2010

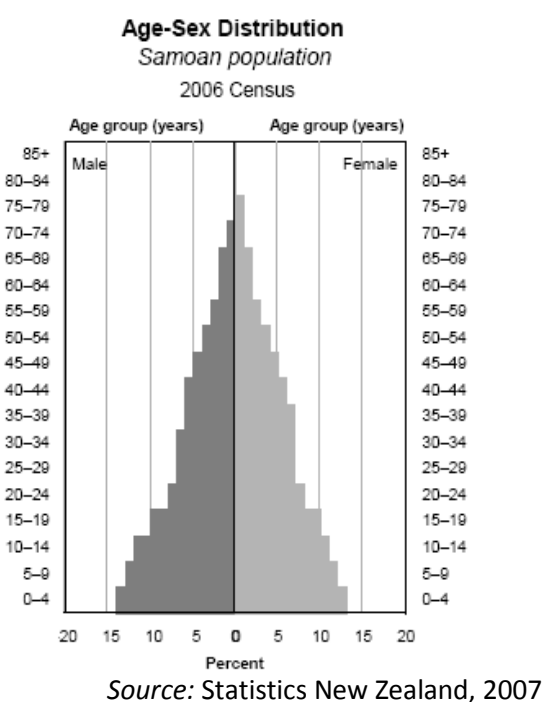
**Figure 2.2.** Age-sex pyramid of Pacific population and New Zealand population as reported in the 2006 Census.

### 2.1.3.3 Age structure

The Pacific population is a youthful one with a median age of 21.1 years, considerably lower than the overall Aotearoa New Zealand general population whose median age is 35.9 years (Statistics New Zealand, 2001a). In 2006, the number of Pacific people under the age of 15 years was 100,344 (38%), relatively greater than the Aotearoa

New Zealand general population (11%). Figure 2.2 provides an illustration of the different age structures. The numbers of Pacific people aged 65 years and over have substantially increased from 5,871 in 1991 to 10,083 in 2006, their relative numbers in 2006 of 4% remains considerably smaller than the Aotearoa New Zealand general population of 12% (Statistics New Zealand, 2006; Statistics New Zealand & Ministry of Pacific Island Affairs, 2010).

The age structure of the Samoan population in Aotearoa New Zealand is similar to that of the Aotearoa New Zealand Pacific population age structure outlined above. Figure 2.3 displays the age-sex pyramid for the Samoan population in Aotearoa New Zealand. Principally, it is a youthful population with a median age of 21.0 years (Statistics New Zealand, 2001a, 2001b; Statistics New Zealand & Ministry of Pacific Island Affairs, 2010). In 2006, the number of Samoan people under the age of 15 years was 49,818 (38%) and the number aged 65 years and over was 5,244 (4%) (Statistics New Zealand, 2007).

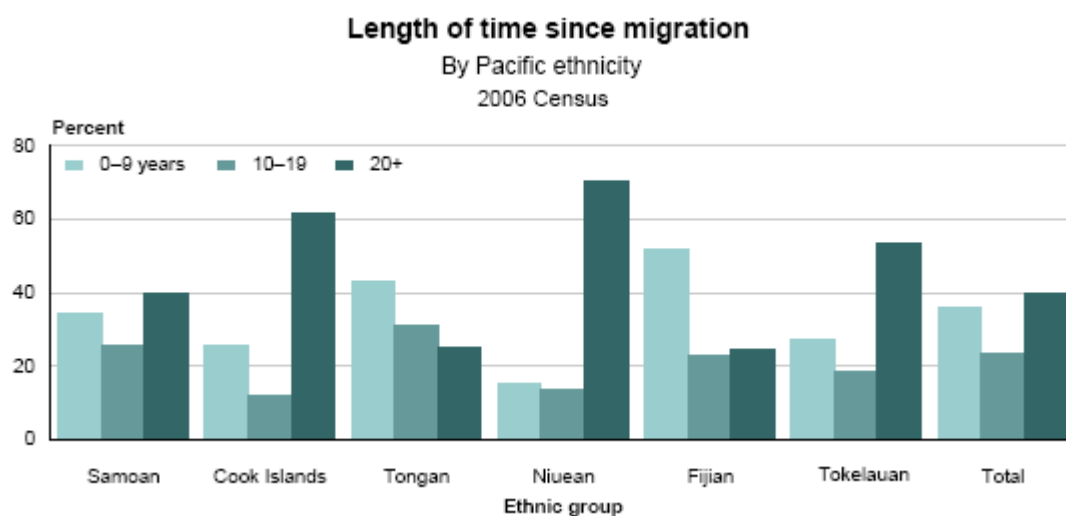


**Figure 2.3.** Age-sex distribution of the Samoan population as documented in the 2006 Census.

#### **2.1.3.4 Birthplace**

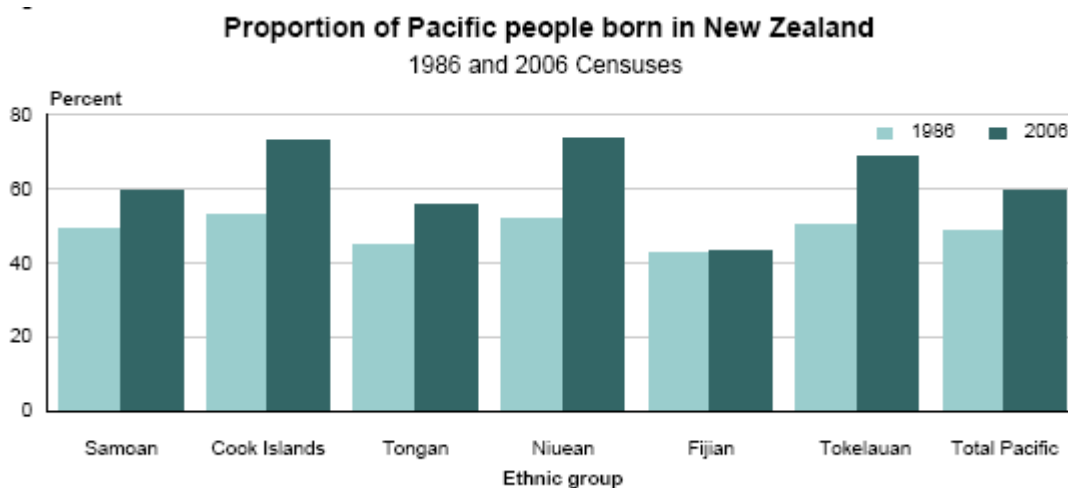
The combined factors of natural increase, a younger age structure, coupled with an increase in the number of inter-ethnic marriages and mobility has mitigated the effect of migration on Pacific population growth. Instead, the current population consists mainly of Aotearoa New Zealand born Pacific people. This is a reflection of how the Pacific population has changed over time from predominately first generation migrants, to now, a largely second, third and beyond generational Aotearoa New Zealand born citizens. This is more pronounced for those Pacific Islanders who have for decades been afforded the same rights and civil liberties of Aotearoa New Zealand nationals, enabling settlement and therefore longer periods to become established in Aotearoa New Zealand. Cook Islanders, Niueans and Tokelauans generally have a longer history in Aotearoa New Zealand than the other Island groups. Figure 2.4 shows the length of time since overseas born Pacific people had migrated to Aotearoa New Zealand. From the graph it is evident that in the 2006 census, Samoans' median length of residence was 18 years. This is 11 years less than Niueans (who have a median length of 29 years) and 9 years less than Cook Islanders (who have a median length of 27 years) (Statistics New Zealand, 2010). This highlights that Pacific nations annexed to Aotearoa New Zealand tend to have longer periods of settlement in Aotearoa New Zealand. In 2006, 77,247 (60%) of the total Samoan population were Aotearoa New Zealand born (Statistics New Zealand, 2007).

Figure 2.5 shows the proportion of Pacific people born in Aotearoa New Zealand between 1986 and 2006 (Statistics New Zealand & Ministry of Pacific Island Affairs, 2010). Within this two decade time span the Aotearoa New Zealand born population had increased from 49% to 60%, a growth of 11%.



Source: Statistics New Zealand and Ministry of Pacific Island Affairs, 2010

**Figure 2.4.** Histogram showing the length of time since overseas Pacific born people had migrated to Aotearoa New Zealand.



Source: Statistics New Zealand and Ministry of Pacific Island Affairs, 2010

**Figure 2.5.** Histogram showing the proportion of Pacific people born in Aotearoa New Zealand for census years 1986 and 2006. Only the six main Pacific ethnic groups in Aotearoa New Zealand are reported: Samoan, Cook Island, Tongan, Niuean, Fijian and Tokelauan along with total Pacific proportions as a reference.

### **2.1.3.5 Multiple ethnicities**

The changing landscape of Aotearoa New Zealand's Pacific population has seen the transformation from a historically predominant migrant population, to Pacific populations born in Aotearoa New Zealand. The rapid emergence of the Aotearoa New Zealand born Pacific population can also be attributed to the inter-ethnic marriages of first and second generation Pacific settlers with Tāngata whenua and Aotearoa New Zealand nationals (Macpherson, 2004). Archival evidence from the 1996 Census showed that 41.9% of Pacific people identified as having more than one ethnicity (excluding those who identified with only one Pacific and multiple Pacific ethnicities) (Bedford & Didham, 2001). Furthermore, birth registrations recorded in 1997 for 7,596 newborn babies of Pacific ethnicity, documented that 4,102 or 54% had more than one ethnicity, while 3,190 or 42% had at least one non-Pacific ethnicity (Cook et al., 2001; Gray, 2001). However these reported figures must be considered with caution as the Census question regarding ethnicity was altered across the three Census years: 1986, 1991 and 1996. These changes have caused significant variations to population counts for Pacific people, particularly between the census years 1991 and 1996 which saw the number of Pacific people identifying as 'Pacific only' "decline in absolute terms" (Bedford & Didham, 2001, p. 29). In 2006, Pacific people identifying with solely one ethnic group had dropped by 70%, with almost half (47%) of Pacific children aged between 0-4 years identifying with more than one ethnicity (Statistics New Zealand & Ministry of Pacific Island Affairs, 2010).

In the 2006 Census, 86,763 (66%) of the Samoan population self identified as solely Samoan (Statistics New Zealand, 2007). In comparison, 28,290 (22%) of the Samoan population self identified as Samoan and one other ethnic group. Of this group, 7,073 (25%) reported as being Samoan and another Pacific ethnic group, while 12,448 (44%) identified as being Samoan/European and 6,224 (22%) identified as Samoan/Māori (Statistics New Zealand, 2007). In addition 11,472 (9%) of the Samoan population self identified as Samoan with two other ethnicities. Of these, 2,294 (20%) were Samoan/Pacific/European – the most common grouping of ethnicities for this population, while 1,032 (9%) reported being Samoan/Pacific/Māori (Statistics New Zealand, 2007). These Samoans identifying with one or two other ethnic groups are

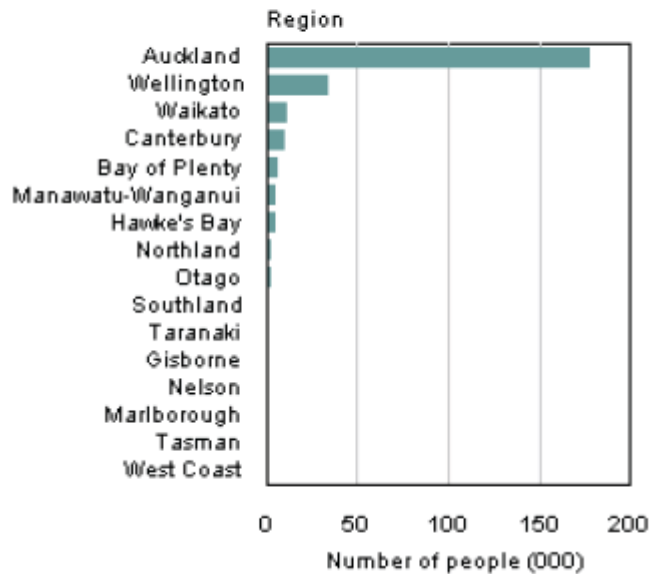
also more likely to fall within the younger age group, with those Samoans identifying with one other ethnicity accounting for 51% of those under the age of 15 years. In comparison 7,342 Samoans with two other ethnicities accounted for 64% under the age of 15 years (Statistics New Zealand, 2007). This further reflects the overall influence and impact this Pacific ethnic group has over the entire Aotearoa New Zealand Pacific demographic profile.

#### **2.1.3.6 Geographical distribution**

The settlement patterns of Pacific migrants have largely influenced the geographical distribution of Pacific people in Aotearoa New Zealand (Statistics New Zealand & Ministry of Pacific Island Affairs, 2010). A densely urbanised population influenced mainly by employment opportunities, Pacific people tended to settle in main city centres, predominantly Auckland, where opportunities for work and education were plentiful (Statistics New Zealand & Ministry of Pacific Island Affairs, 2010). These city centres also happen to be home to the main entry ports into Aotearoa New Zealand (Cook et al., 2001; Statistics New Zealand & Ministry of Pacific Island Affairs, 2010) making access into these urban city centres easier. However, it was the places within Aotearoa New Zealand where family members were already established, with communities they had built and interacted with which attracted new Pacific migrants the most (Cook et al., 2001; Statistics New Zealand & Ministry of Pacific Island Affairs, 2010). This is evident in the 2006 Census which reported that 257,995 (97%) of the Pacific population resided in urban areas, with 244,696 (92%) in the main 25 urban areas. About two thirds of the Pacific population can be found in the Auckland region (Cook et al., 2001; Statistics New Zealand, 2006; Statistics New Zealand & Ministry of Pacific Island Affairs, 2010), with a total of 175,543 Pacific people living in Auckland alone (see Figure 2.6). Wellington is home to the second largest Pacific population, housing around 34,577 (13%) Pacific people (Statistics New Zealand, 2006), while the South Island is home to the smallest number of Pacific people with a total of 18,618 or 7% (Statistics New Zealand, 2006).



### Regional Distribution of the Pacific Peoples Ethnic Group *2006 Census*



*Source:* Statistics New Zealand, 2006

**Figure 2.6.** Bar graph showing the regional distribution of the Pacific peoples ethnic group

The geographical distribution of the Samoan population is highly reflective of the geographical distribution of Pacific people in general. Samoans like their earlier settling relatives occupy the urban city centres within Aotearoa New Zealand (Statistics New Zealand, 2007). In the 2006 Census, 128,481 (98%) of Samoans resided in urban areas with 87,003 (68%) (the largest number of Samoans) residing in Auckland (Statistics New Zealand, 2007).

## **2.2 Samoan population in Samoa**

### **2.2.1 Early South East Asian migration to Samoa**

The Samoan people in Samoa were not always inhabitants of the island archipelago. Rather, the Samoan archipelago was settled by South East Asian migrants some 3000 years ago (Irwin, 2006; Macpherson & Macpherson, 2009; United States Department of State, 2008). From here, descendents of these early Samoan settlers set ashore to explore eastward of Polynesia, each time inhabiting the archipelagos they encountered on their seafaring explorations (Macpherson & Macpherson, 2009; United States Department of State, 2008). Those who remained within the Samoan archipelago would be forever known as the “first Samoans” (Macpherson & Macpherson, 2009, p.26). It is the direct descendents of these first Samoans, the present generation of Samoan inhabitants that is of particular interest to the current research and overall thesis topic, as they provide the comparative population for which the present study is dependent upon. The following section will provide a brief history of the Samoan Islands, culture, its people and their health status.

### **2.2.2 A brief history of Samoa**

To understand why this group was considered as the comparative population for the current research, it is important to understand the island nation’s history, and in particular, its historical ties with Aotearoa New Zealand. The early 1700s saw the arrival of the first Europeans to the Samoan archipelago. However, it would be the arrival of the European missionaries and traders in the 1830s that would have the biggest impact on Samoa society (United States Department of State, 2008), helping to shape many of the social institutions in Samoa today (Macpherson & Macpherson, 2009). By 1900, the desires of the colonial powers from Germany, Britain and the United States of America to govern Samoa resulted in Germany taking control of the islands in the west of the archipelago (Western Samoa), while the United States of America ruled those islands in the east (known as American Samoa) (United States Department of State, 2008). This signalled the end of Britain’s assertion in Samoa and a shift in the ‘empire’s’ attention to Tonga (Macpherson & Macpherson, 2009).

In 1914, Aotearoa New Zealand took control of Western Samoa from Germany (on behalf of the British government) and governed with the support of the League of Nations mandate which in turn became a United Nations trusteeship until 1962 when Western Samoa became the first Pacific archipelago to become an independent state (Macpherson & Macpherson, 2009; United States Department of State, 2008). Despite its newfound independence, it would not be until 1997 when the country's name, Western Samoa, a reminder of its colonial past was changed. An amendment to the Samoan constitution (in July 1997) saw the name changed to Samoa, officially the Independent State of Samoa. However, the name change encountered opposition from the neighbouring American Samoans who felt the amendment would reduce their own Samoan identity (United States Department of State, 2008). Nevertheless the name change went ahead and Western Samoa became Samoa. It is important to note that although (Western) Samoa and American Samoa came to be governed by different states/countries/nations; both nations share the same traditional culture, and associated values and beliefs. It is important to note that the only difference between (Western) Samoa and American Samoa is their governing body. As such, each shares the same culture and associated values and beliefs (Deka et al., 1994).

The focus of the present research on (Western) Samoans (as opposed to American Samoans) is largely due to the historical ties Aotearoa New Zealand shares with this particular archipelago. As previously alluded to, Aotearoa New Zealand as the understudy to British governance, took over the administration of Western Samoa in 1914 up until Samoa became an independent state in 1962 (Macpherson & Macpherson, 2009). During this time, the Aotearoa New Zealand administration in 1918 allowed the SS Talune ship carrying the Spanish flu to land on the Samoan Islands. This grave lapse of judgement by Aotearoa New Zealand officials would cause the death of some 8,000 rural Samoans. In 1936, back in Aotearoa New Zealand, a change of government would see Samoans receive compassionate consideration with talks of Aotearoa New Zealand having only a consultative role in governing; however these discussions were cut short due to the drafting of Aotearoa New Zealand troops into the Second World War. Subsequent to the war ending, Samoans hoped to reignite Aotearoa New Zealand's pre-war talks about Samoa's self governance. It was

during Aotearoa New Zealand's administration under the United Nations trusteeship in which the Samoans' hope would be realised when Aotearoa New Zealand's governing arm began preparing Samoa for independence. At the same time, New Zealand experienced an expansion in its industrialised sector and in turn required a large number of labour recruits to fill the excess labour demands. (Western) Samoans, among other Pacific groups, responded by arriving in increased numbers from 1945. In 1962, having gained independence, Samoa also signed a treaty of friendship agreement with Aotearoa New Zealand, affording Samoa continued assistance from Aotearoa New Zealand (Macpherson & Macpherson, 2009). However, the mid 1970s global oil crisis would mark the end of the open immigration policies into Aotearoa New Zealand for certain Pacific groups, specifically those from Samoa, igniting the era of dawn raids. Ironically the deportation of a Samoan woman, Falema'i Lesa in 1979 (and her subsequent successful appeal to the Privy council) highlighted the blatant racist nature of previous Aotearoa New Zealand governments in denying (Western) Samoans (born between 1924 and 1948 and their descendents) citizenship rights under the 1949 Aotearoa New Zealand Citizenship Act (Green, 2009: New Zealand History Online, n.d.). The Aotearoa New Zealand government reacted to the Privy council ruling by offering the (Western) Samoan government a concession whereby those (Western) Samoans already residing in Aotearoa New Zealand or had permanent residency could obtain Aotearoa New Zealand citizenship (New Zealand History Online, n.d.). Therefore it is these historical ties which Aotearoa New Zealand and (Western) Samoa share that justify the focus of this current research on (Western) Samoans.

### **2.2.3 Culture and social norms**

Given that the present study involves a comparative population from the island nation of Samoa, it is important to consider its culture and social customs. Samoa is a nation entrenched in tradition, culture, values and beliefs. As such, the Samoan culture itself may play a role in the success of conducting research in Samoa. The following section outlines some key features about Samoan culture worthy of note that may be important to consider when carrying out research.

### 2.2.3.1 Fa'aSamoa

Fa'aSamoa is translated in English as the Samoan way of life; however the concept is far more multifaceted than the English definition portrays. Fa'aSamoa is a set of commonly held beliefs amongst Samoans. These beliefs commonly reference a world view, inherent cultural beliefs, rituals, protocols and behaviours that govern and result from the overall Samoan social and political structures (Lilomaiva-Doktor, 2004; Tuagalu, 2008; Puaina, Aga, Pouesi & Hubbell, 2008). There are cultural rules that prescribe appropriate behaviour. These rules range from what to wear to how to act and speak in certain situations. Fa'aSamoa is a concept pertinent to the identity of all Samoans, to those residing within the ancestral homelands as well as diasporic Samoans, as fa'aSamoa provides the foundation for Samoan life. A unique form of governance, fa'aSamoa dictates the social organisation within the *nu'u* or village communities. Thus, although modern Samoa is becoming more industrialised, Samoan social organisation remains centred around the village. Each *nu'u* is governed by a fa'amatai system, specifically a collective of *matai* or chiefs. The fa'amatai system regulates village matters including the *'āiga* (family units) that comprise the *nu'u*. The system works as each member within the village is divided into one of five social groups: the *matai* (chiefs of the village), *faletua ma tausima* (wives of the matai), *'aumaga* (group of untitled men), *tama'ita'i* (young women) and *tamaiti* (children). Members of each group then have their own specific roles and responsibilities that dictate their interactions within their specific group as well as with the other four social groups. The interactions and relationships between these five divisions are centred on the concept of *vā* i.e. relational space.

### 2.2.3.2 Vā

According to Tuagalu (2008), *vā* embodies not only the social, but also the spiritual relationships connecting people. *Vā* is simply defined as, and is commonly used among Samoans to describe, the spatial relations of respect and appropriate conduct between people. The *vā* provides a set of rules for engagement that Samoans observe when interacting with each other and their environment, particularly within their distinct group and between groups (see Tuagalu, 2008 for a comprehensive account). Knowing the *vā* and how to *teu* or respect and honour the 'space' is the responsibility of those

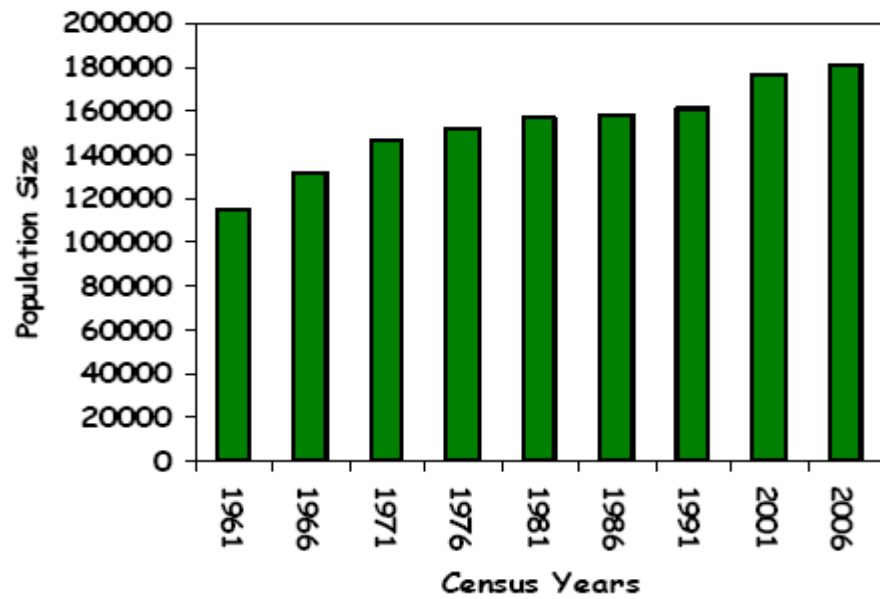
who are in relation with another. Like fa'aSamoa, the *vā* concept is hierarchical, multifaceted, and intrinsic within those Samoans who observe it. Similarly those who acknowledge the *vā* are more likely to be reciprocated with *vā* observances than those who choose not to, gaining (at the least) respect for their attempt in recognising Samoan cultural protocols. Essentially, it would be the observing of the *vā* between Samoans in Samoa, including kinship ties and Samoans in Aotearoa New Zealand that would have the greatest implications for the collection of data in Samoa. In the end, it was this crucial concept, the *vā* and observing it, that led to successfully obtaining the birth weight data from the Samoan Ministry of Health. The *vā* is revisited in the methods section of this thesis for its crucial role in data collection.

#### **2.2.4 Demographics of Samoans in the Independent State of Samoa**

Having discussed why Samoans from the Independent State of Samoa were considered in the current research as the comparative population, and the importance of considering the uniqueness of its culture in conducting research, attention turns now to outlining some demographic information that may also support the contention of using Samoa as a comparative population.

##### **2.2.4.1 Population growth**

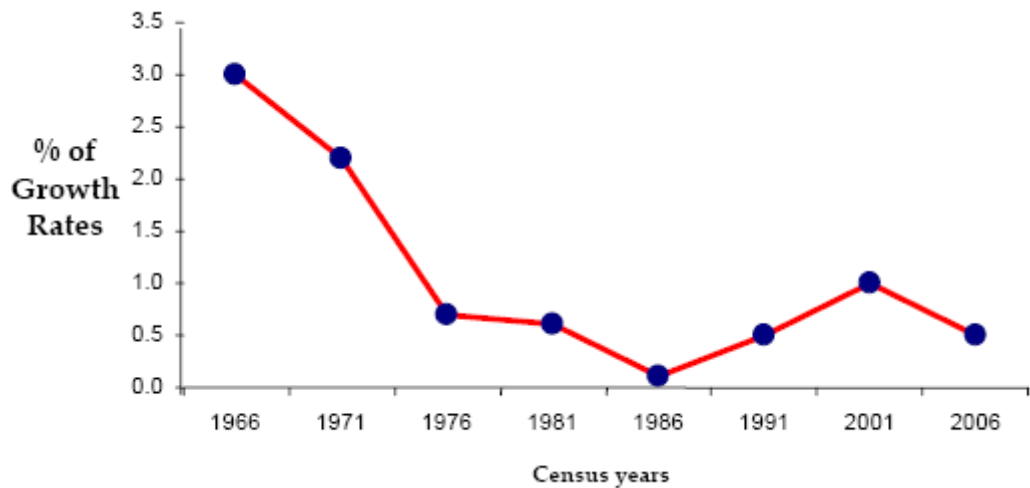
In 2006, the total number of Samoan persons enumerated was 180,741. This is an increase of 3% (or 4,031 people) since 2001 (Samoa Bureau of Statistics, 2008). Figure 2.7 shows the size of the Samoan population for census years 1961 through to 2006. Although the Samoan population has a high fertility rate which has contributed to a steady population growth each year, the growth has been minimal over the last 45 years, particularly during the 1970s and 1990s which saw the population growth decline from 2% to 0.1% each year (Samoa Bureau of Statistics, 2008). Samoans migrating in large numbers for work opportunities to countries such as New Zealand, Australia, United States and American Samoa largely account for the decline in the Island's population during this period (see Figure 2.8).



Source: Samoa Bureau of Statistics, 2006

**Figure 2.7.** Bar graph showing the size of the Samoan population for the 1961 census year through to the 2006 .census year.

Interestingly from Figure 2.8, the census periods spanning 1986 to 2001 saw an increase in the population growth. However this was short lived with the population declining from a reported annual growth rate of 1.0% in 2001, to 0.5% in 2006 (Samoa Bureau of Statistics, 2008). The decline again reflects the significant effects of migration on Samoa's population growth, with Samoa losing much of its young, strong labour force to the outside world. However the effects have also been beneficial to the Samoan people and economy as these (large numbers of) Samoans seeking opportunities abroad has afforded the many remaining Samoan families a source of income through remittances. In the same way, emigration has allowed Samoa to regulate its potential to have a high population growth as the Island Samoans like the Samoan population in New Zealand have a high fertility rate (Samoa Bureau of Statistics, 2008).



Source: Samoa Bureau of Statistics, 2006

**Figure 2.8.** Line graph showing the annual growth rate of the Samoan population for census years 1986 to 2006.

#### 2.2.4.2 Age structure

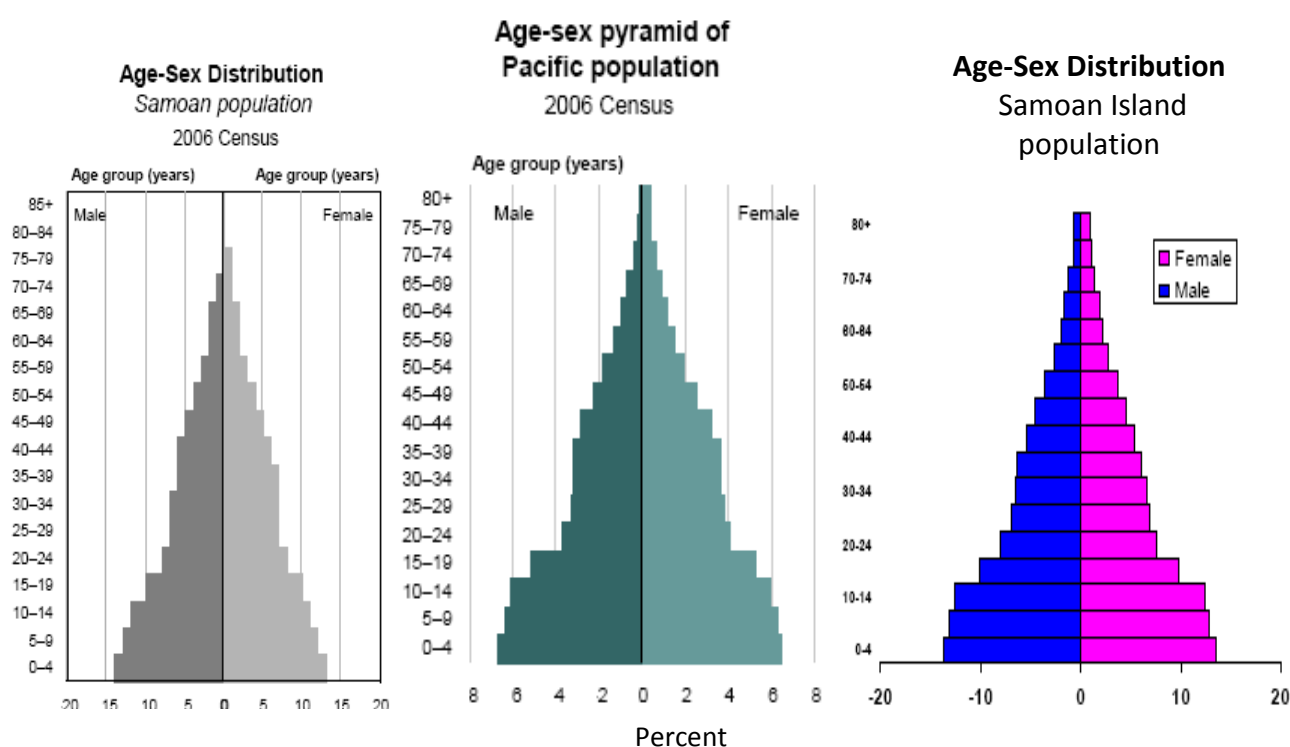
The age structure of the Samoan population is parallel to that of the Samoan and Pacific population age structure in New Zealand (as outlined above). As such, it is a youthful population with a median age of 20.5 years (Samoa Bureau of Statistics, 2008), only 0.5% and 0.6% younger the median age of the Samoan and Pacific population in New Zealand respectively (Statistics, 2001a, 2001b; Statistics New Zealand & Ministry of Pacific Island Affairs, 2010). The number of Samoans under the age of 15 years was 70,489 (39%) (Samoa Bureau of Statistics, 2008), which is similar to that seen in Aotearoa New Zealand. Also comparable to the Aotearoa New Zealand Samoan and Pacific populations is the small number of Samoan people aged 65 years and over, accounting for only 5% of the total Samoa population in 2006.

#### 2.2.4.3 Gender

The gender distribution of Samoans is similar to the gender distribution of Samoans and Pacific populations in Aotearoa New Zealand. Figure 2.9 displays the age-sex distributions for all three populations. In the 2006 Census, there were slightly more males 93,677 (51.7%) compared to females 87,064 (48.2%) (Samoa Bureau of Statistics, 2008). The dominance of males among the younger age groups has been



consistently observed over the last three decennial censuses: 1981, 1991 and 2001 (Samoa Bureau of Statistics, 2008). Yet a different scenario depicts that of the 50 years and over age group where females are more common than males. The difference has been attributed to the impact of emigration which sees more males than females migrating overseas (Samoa Bureau of Statistics, 2008).



Source: Statistics New Zealand and Ministry of Pacific Island Affairs, 2010; Statistics New Zealand, 2007; Samoa Bureau of Samoa, 2008

**Figure 2.9.** Side by side age-sex pyramids of Pacific and Samoa populations in Aotearoa New Zealand and the Samoa Island population as reported in each countries respective 2006 Census.

#### 2.2.4.4 Multiple ethnicities

Despite Samoa's long history of attempted colonization by various foreign forces, the dominant ethnic group in the Samoa archipelago today is still Samoan. From a total population of 180,741 recorded in the 2006 Census, 97% (or 176,005) self identified as being solely Samoan. The remaining 3% (5,422) of the total population recorded in the 2006 Census were categorised as Non Samoans despite a large majority of this population comprising of people who identified as Samoan with one other ethnicity

(1,502 or 28%). Of this group, 452 or 30% self identified as Samoan and one other Pacific ethnic group, while 543 or 36% identified as being Samoan/New Zealander (Samoa Bureau of Statistics, 2008). The remaining 438 which equates to 31% consist of various ethnic combinations between Samoan/Australian (108 or 8%), Samoan/American (136 or 10%), Samoan/Asian (181 or 13%) and Samoan/European (70 or 7%) (Samoa Bureau of Statistics, 2008).

#### **2.2.4.5 Geographical distribution**

The Samoan Island population is geographically distributed among four major statistical regions: Apia Urban Area, North West Upolu, Rest of Upolu and Savaii. The latter three regions collectively comprise the rural population of Samoa. The Apia Urban Area encompasses the urban area of Samoa and constitutes almost one quarter of the Samoan population, specifically 21% equating to 37,708 people. While the rural areas: North West Upolu, Rest of Upolu and Savaii collectively account for the remaining 79%, with 31% or 56,122 residing in North West Upolu, 24% or 43,769 in Rest of Upolu and 24% or 43,142 individuals in Savaii (Samoa Bureau of Statistics, 2008). Population growth within the Apia Urban Area region has been stagnant particularly between the 2001 and 2006 census years. However, it remains to be the most densely populated with the migration of rural residents into city centres seeking better job opportunities, social and economic services such as health facilities and schools (Samoa Bureau of Statistics, 2008).

## **2.3 Health status of Aotearoa New Zealand Pacific, Aotearoa New Zealand Samoan and Samoan populations**

### **2.3.1 The health status of the Pacific population in Aotearoa New Zealand**

The health status of Pacific people continues to be relatively poor in comparison to the general Aotearoa New Zealand population (Ministry of Health & Ministry of Pacific Island Affairs, 2004; Statistics New Zealand, 2002). Although there have been improvements in life expectancy and mortality rates, Pacific people continue to dominate the charts in morbidity and mortality rates which are more often than not avoidable and potentially preventable conditions (Ministry of Health & Ministry of Pacific Island Affairs, 2004; Statistics New Zealand, 2002). For example, the leading cause of avoidable death for Pacific adults is ischaemic heart disease. A major health issue gaining notoriety for its devastating effects on families and their communities, ischaemic heart disease is not only prevalent among Pacific people but also among other ethnic minorities, specifically Tāngata whenua (Ministry of Health, 2001c, 2010). Because of its widespread effects, particularly on minority populations such as Pacific people, it is only appropriate that government health agencies and health professionals highlight risk factors and preventative steps to reduce its prevalence. In the same way, special attention should also be given to the leading causes of death among the younger Pacific population (0 to 14 years) and particularly the complications during the perinatal period (Ministry of Health & Ministry of Pacific Island Affairs, 2004; Statistics New Zealand, 2002) such as prematurity and complications during the birth process (Ministry of Health & Ministry of Pacific Island Affairs, 2004). Perinatal complications are a serious concern considering Pacific infants have a 40% higher infant mortality rate than the average Aotearoa New Zealand infant (Ministry of Health & Ministry of Pacific Island Affairs, 2004; Ministry of Health, 2005). Moreover, the avoidable and preventable adult diseases such as ischaemic heart disease and obesity experienced by Pacific people have been linked to birth weight and other adverse birth outcomes such as preterm (Ministry of Health & Ministry of Pacific Island Affairs, 2004) and low birth weight (Barker, Winter, Osmond, Margetts & Simmonds, 1989; Valdez, Athens, Thompson, Bradshaw & Stern, 1994) .

### **2.3.2 The health status of the Samoan Aotearoa New Zealand population**

As a consequence of being the largest Pacific ethnic group in Aotearoa New Zealand, the health status of Samoans is understood to largely be synonymous with that of the wider Pacific population in Aotearoa New Zealand. Naturally, one would assume the causes of avoidable and non-communicable mortality are also parallel. However, Blakely et al. (2009), using hierarchical Bayesian models to examine whether differences in mortality rates existed between the four major Pacific ethnic groups in Aotearoa New Zealand: Samoa, Cook Island Māori, Tongan and Niuean, found that Cook Island Māori had elevated cardiovascular disease mortality rates, while Niueans presented with lower injury/suicide mortality rates compared to other Pacific groups. The first and only study known to examine the separate mortality rates of the four major Pacific groups in Aotearoa New Zealand, Blakely et al. (2009) strongly advocate the use of heterogeneity Pacific health status by future health researchers and policy makers. The PIF study has conducted several studies on the Pacific cohort engaged in their longitudinal study and have also demonstrated considerable heterogeneity across Pacific groups, such as Butler, Tukuitonga, Paterson & Williams' (2002) study of infant feeding patterns and associated problems across the four main Pacific ethnic groups: Samoan, Cook Island, Niuean and Tongan. Another PIF study that reports separate Pacific ethnic group findings include Tautolo, Schluter & Sundborn's (2009) study examining the mental health of fathers amongst Samoan, Cook Island, Tongan and other Pacific ethnic groups. However, more research on the separate Pacific ethnic groups (across the various Pacific groups and within each specific Pacific ethnic group) and their varied health outcomes is needed. Not until then will a comprehensive account of each specific Pacific group's poor health status be known.

### **2.3.3 The life expectancy of the Pacific population in Aotearoa New Zealand**

The life expectancy at birth of Aotearoa New Zealanders has increased (Statistics New Zealand, 2002). National figures reported an increase from 74.3 years to 76.3 years for males, and 79.6 years to 81.1 years for females between 1996 and 2002 (Statistics New Zealand, 2002), an increase of two years for the national rate of both sexes, with a

gender gap of 4.8 years. Pacific people have also experienced increases in life expectancy at birth, with Pacific males experiencing an increase of 1.7 years, and Pacific females an increase of 1.1 years over the same period (year 1996 to 2000-2002) (Statistics New Zealand, 2002). Despite the increases in life expectancy experienced by both groups, Pacific people's life expectancy continues to be lower than the national average, with Pacific males being 4.8 years and Pacific women 4.4 years lower than their Aotearoa New Zealand counterparts (Ministry of health & Ministry of Pacific Island Affairs, 2004). Thus Pacific males on average can expect to live 71.5 years while Pacific females on average can expect to live 76.7 years, a 5.2 year gender gap (Ministry of health & Ministry of Pacific Island Affairs, 2004).

#### **2.3.4 The life expectancy of the Samoan Aotearoa New Zealand population**

Principally, the life expectancy of Samoans in Aotearoa New Zealand would mirror the life expectancy estimates documented for Pacific people. Current literature on life expectancy in New Zealand continues to report estimates for Pacific people as one homogenous group (Ajwani, Blakely, Robson, Tobias & Bonne, 2003; Ministry of Health & Statistics New Zealand, 2009; Ministry of Health, 2001a, 2001b, 2003), even after these very same authors acknowledge the cultural diversity within and between Pacific people and the need for more Pacific ethnic specific research (Blakely et al., 2009). This again highlights the dearth in Pacific ethnic specific research in Aotearoa New Zealand, and the necessity for more comprehensive investigation into the multiplicity of the Pacific population and their ethnic specific needs.

#### **2.3.5 The health status of Samoans in Samoa**

The health of Samoans in Samoa as described by the Ministry of Finance - Samoa (2008) is "good" (p. 31). Life expectancy rates have increased, while maternal, infant and child mortality has decreased, affording Samoa bragging rights for having already achieved Goal 4 of the Millennium Development Goals set out by the UNFPA; to '*reduce child mortality by two thirds for children under the age of five*' (United Nations, 2008; Ministry of Health. Samoa, 2008). Despite these improvements, Samoans continue to experience poor health outcomes (Government of Samoa & Unicef, 2006).

Non communicable diseases such as diabetes, obesity, hypertension and heart disease are most prevalent among Samoans residing in urban areas. These lifestyle diseases are also the leading cause of death in Samoa. Furthermore communicable diseases rank among the top 10 causes of hospitalisation with complications of labour, delivery and pregnancy the leading cause of admission to the National hospital of Samoa. Therefore it is important to consider the factors that contribute to the poor health outcomes experienced in Samoa, particularly those which affect the health of expectant mothers and their child(ren).

### **2.3.6 The life expectancy of Samoans in Samoa**

The life expectancy of Samoans in Samoa has improved (Ministry of Finance. Samoa, 2008). Figures in the 2006 Census reported 71.5 years for males and 74.2 for females, an increase of 0.4 years for females from 73.8 years reported in 2001 Census, while the life expectancy of males remained stagnant for the same period.

## **2.4 Birth weight and indicators of health**

### **2.4.1 Infant mortality**

The death of an infant or child is understandably one of the most heartbreaking events in life. Defined as the “number of infant deaths during the first year of life” (Duval County Health Department, 2006, p. 1) infant death is a critical indicator of health and social wellbeing (Cramer, 1987; Frisbie, 2005; Pampel & Pillai, 1986; Singh & Yu, 1995). Infant mortality is caused by a number of neo-, peri- and post-natal conditions, including maternal complications during pregnancy, sudden infant death syndrome, birth defects, pre-term delivery (before 37 weeks gestation) and low birth weight (less than 2500 grams) (Duval County Health Department, 2006) and is influenced by many different socioeconomic, demographic and biomedical factors (Frisbie, 2005). Although infant mortality rates have been declining in both developing and developed nations, it still remains higher for developing countries compared to their developed counterparts (Frisbie, 2005; Pampel & Pillai, 1986). Nevertheless, even in developed nations, which are expected to have better health and social outcomes, the rate of infant mortality is relatively high. The United States’ infant mortality rate for example, has consistently been high relative to other developed nations, in the past four decades (Singh & Yu, 1995; Li, Daling & Emanuel, 2003). Moreover, regardless of the country’s development stage, the rate at which infant mortality declines differs across societies, and groups within the same society (Cramer, 1987; Frisbie, 2005). For instance, it has been well documented that there exists ethnic differences in infant mortality within the United States. Black Americans have always had a higher risk of infant mortality than their White counterparts (Frisbie, Forbes & Pullum, 1996; Hummer et al., 1999; Kallan, 1993), and among Hispanic groups (i.e., Mexican, Puerto Rican, and Cuban), people of Mexican descent are most at risk of infant mortality (Hummer, Eberstein & Nam, 1992).

### **2.4.2 Risk factors associated with infant mortality**

A number of risk factors have been associated with infant mortality (Frisbie, 2005). These include socioeconomic factors (such as maternal education, and household

income), demographic factors (such as maternal age, and maternal marital status), and biomedical factors (such as previous pregnancy loss, previous pre-term and small for gestational age births, maternal morbid conditions and birth outcomes).

A universal underlying risk factor for infant mortality that has been widely documented is the inequities within socioeconomic factors (Singh & Yu, 1995; Li et al., 2003). Of these, the most indicative of a baby's survival and birth outcomes, is a mother's level of education (Frisbie, 2005; Pampel & Pillai, 1986; Hummer et al., 1992, 1999). Studies examining the relationship between maternal education and infant survival and longevity have consistently found a positive association, even after adjustments have been made to other risk factors (Hummer et al., 1999). The more education a mother receives, the more reduced is her baby's risk of infant mortality (Singh & Yu, 1995; Bross & Shapiro, 1982; Mathews, Menacker & MacDorman, 2004). This might be because educated women are more likely than their less educated counterparts to have greater access to resources such as income due to their educational attainment.

Another established factor influencing an infant's chance of survival during its first year of life is its mother's socioeconomic status, and particularly her (household) income. Mothers with low socioeconomic status are at higher risk of losing their infant within the first year of life, and furthermore, are more inclined to have low birth weight babies (Frisbie, 2005). The experience of the Pacific population in Aotearoa New Zealand contrasts this, as although Pacific people are generally of a lower socioeconomic status than other Aotearoa New Zealanders (Statistics New Zealand & the Ministry of Pacific Island Affairs, 2002), Pacific mothers are less likely to have babies of low birth weight (Ministry of Health & Ministry of Pacific Island Affairs, 2004). However, there are arguments that higher incomes also contribute to high infant mortality rates (Pampel & Pillai, 1986; Costa, 1998). This paradox might exist with regards to income because income can be construed as an "enabling variable" (Costa, 1998, p. 990). With higher income, women are able to have greater access to better nutrition and medical care, therefore reducing the risk of their infants dying. Nonetheless, having more "discretionary income" (Pampel & Pillai, 1986, p. 527) also enables women to engage in unhealthy habits, such as smoking, and drinking alcohol



(Costa, 1998) which in turn increases the risk of infant mortality. Socioeconomic status and income therefore appears to be an important determinant of infant mortality.

Under the demographic risk factors, maternal age is often associated with infant mortality (Hummer et al., 1999). This association is largely curvilinear in nature, where the incidence and risk of infant mortality is high for both younger (i.e., teenage) and older mothers (Singh & Yu, 1995; Bross & Shapiro, 1982). The risks for older women are likely to be due to biological factors such as reproductive health, while for younger women, the risk is likely due to having less access to resources (e.g., income) (Hummer et al., 1999). The number or order of children a mother gives birth to (i.e., maternal parity) is also associated with infant mortality (Cramer, 1987), with first births (Kallan, 1993) and women with a greater number of children being at increased risk (MacDorman, Declercq, Menacker & Malloy, 2006).

Another widely discussed demographic risk factor influencing infant mortality is marital status. Research has found that an infant born to an unwed mother is at higher risk of mortality than an infant born to a married mother (Frisbie, 2005; Singh & Yu, 1995; Li et al., 2003; Hummer et al., 1999; Mathews et al., 2004). However, this association may be due to more favourable familial and socioeconomic resources experienced as a result of marriage (Eberstein, Nam & Hummer, 1990). Maternal demographics therefore also appear to have an important influence on an infant's risk of mortality.

The associations that exist between these risk factors and infant mortality may result for a number of reasons (Li et al., 2003; Bross & Shapiro, 1982; Eberstein et al., 1990). The relationships between infant mortality and the factors described may not only be mediated by other factors, but are intertwined and work together with other factors to determine an infant's risk of death within its first year of life. For instance, maternal age (i.e., older mothers tend to risk having higher infant mortality) may influence infant mortality negatively because with age, the risk of congenital malformations increases, thereby increasing the risk of infant mortality. Similarly, the unfavourable associations between infant mortality with ethnicity and marital status might be explained by the differences that exist when considering socioeconomic factors; as

some ethnic groups (e.g., ethnic minorities) and unwed mothers are more likely to have less access to resources (e.g., money, affordable housing, adequate healthcare) therefore increasing risk of infant mortality.

Other than demographic variables, important biomedical indicators of birth outcomes for both mother and infant have also been identified as increasing the risk of infant mortality. One such risk factor is previous pregnancy loss through miscarriage or stillbirth (Frisbie, 2005; Eberstein et al., 1990) where previous pregnancy loss is thought to reflect a woman's reproductive health. Therefore having previous miscarriages or stillbirths puts a woman's baby at greater risk of later infant mortality. The association with previous pregnancy loss and infant mortality is also concerned with maternal morbid conditions such as hypertension, which also contributes to both mothers and infants experiencing adverse birth outcomes including death (Frisbie, 2005; Roberts, Pearson, Cutler & Lindheimer, 2003). Maternal health therefore is an important determinant of infant survival.

#### **2.4.3 Low birth weight as a primary risk factor of infant mortality**

The key biomedical risk factor dubbed as the most proximate and powerful predictor of infant survival and mortality is birth weight (Frisbie, 2005; Eberstein & Parker, 1984), and more specifically, low birth weight (Hummer et al., 1999). Infant mortality for low birth weight infants can be as great as 20 times that of their normal birth weight counterparts (United Nations Children's Fund & World Health Organization, 2004; Boardman, Powers, Padilla & Hummer, 2002). What determines an infant's birth weight? There is some consensus that the infant's length of gestation (i.e., the period between conception and birth) (Frisbie, 2005), and its foetal intrauterine growth (i.e., its maturation within the uterus) affect its ultimate weight at birth. Any interference in either of these processes may impair foetal growth resulting in the birth of babies that are small for gestational age and/or low birth weight (Li et al., 2003; Shah & Ohlsson, 2002).

Moreover, the factors that influence the risk of infant mortality (as briefly outlined above, e.g., socioeconomic, demographic and biomedical factors) do so through their

effect on birth weight, and in particular, low birth weight (Eberstein et al., 1990; Eberstein & Parker, 1984). That is, (low) birth weight largely mediates the association between socioeconomic factors for example, and infant mortality. Income for instance influences an infant's risk of death during its first year of life because of its effect on the infant's birth weight. As outlined above, income can either enable mothers to have better nutrition for example (and therefore a greater likelihood of having a healthy weight baby), or indulge in higher risk behaviours such as smoking and consuming alcohol (which reduces their infant's birth weight) (Costa, 1998; Chomitz, Cheung & Leiberman, 1995), both of which subsequently differentially affect their baby's risk of infant mortality. Therefore the determinants of birth weight are synonymous with those of infant mortality (Costa, 1998) and low birth weight significantly increases the risk of death in the first year of life.

One factor that has been alluded to before, that has great implications on birth weight (and therefore infant mortality) is maternal nutrition (Costa, 1998). The amount of weight or lack thereof, which a mother gains during pregnancy, has an effect on foetal size (Chomitz et al., 1995). Women who are of low weight pre-pregnancy and who gain relatively little weight during pregnancy tend to have smaller babies (Costa, 1998; Barker, 2003). However, only at significant deprivation thresholds of nutrition can the weight of the mother impact on the birth weight of her unborn child, as protective mechanisms within the uterus serve to shield the foetus from being undernourished (Costa, 1998). When maternal nutrition does affect the infant's birth weight, it predetermines the infant's risk for developing chronic illnesses such as Type II diabetes, coronary heart disease, hypertension and stroke later in life (Barker, 2003, 2004; Osmond & Barker, 2000). Barker argues that these adult diseases are pre-programmed when the foetus is undernourished whilst in the uterus, which in turn determines its birth weight. Birth weight, and in particular low birth weight, therefore not only has important implications for infant and child mortality, but also morbidity later in adult life.

However, contrary to the universally accepted ideology of many epidemiologists and health researchers that birth weight is the most significant predictor of an infant's survival and mortality, is Wilcox's (2001) article titled "On the importance – and the

unimportance-of birthweight [sic].” In his commentary, Wilcox (2001) questions the causal relationship between birth weight and health outcomes. He purports that birth weight alone does not predict mortality; rather, it is the birth weights positioned within the tails of a normal birth weight distribution, in particular the births within the lower tail, namely the residual distribution, that have the greatest effect on infant mortality. Wilcox (2001) argues that births that fall within the residual distribution are small, preterm and at higher risk of infant mortality, while births that fall within the upper tail have little/reduced effect on mortality. Furthermore, Wilcox (2001) also questions Barker’s theory on causal relationships between foetal nutrition and adult health, promulgating instead his argument against birth weight and mortality being causal may also have similar implications for foetal nutrition and adult outcomes. Instead Wilcox (2001) supports the notion that genetics may be the factor contributing to foetal growth and adult morbidity.

Like Wilcox (2001), the United Nations Children’s Fund and World Health Organization (2004), recognizes that birth weight alone does not offer an explanation for various pregnancy outcomes and instead argues the need for broader definitions (of pregnancy outcomes) particularly in light of recent developments concerning factors that impact infant development during intrauterine and infancy.

Having presented both sides of the argument on the significance or insignificance of birth weight on infant survival, mortality and later adult morbidity, what remains then, and is pertinent to the current study, is the definition of low birth weight. The low birth weight threshold of <2500 grams was originally coined by Finnish paediatrician Dr Arvo Ylppö in 1920. Based on his postdoctoral studies of several hundred infants and 600 post mortem examinations, Ylppö replaced the notion of “congenital weaklings” with “premature infants” to characterise birth weights that were equal to, and less than 2500 grams. This definition of low birth weight continues to be used universally today as the standard measure of low birth weight.

However, it would not be until five decades later in a special article (published in the Journal of Pediatrics) where Wilcox and Russell (1990) reignited the long standing debate around the inadequacies of the standard low birth weight threshold and

advocated the use of population specific standards for birth weight. Using earlier epidemiological studies which were conducted shortly after Ylppö coined the low birth weight criterion, Wilcox and Russell (1990), in the opening paragraph of their article, provided a brief history of research that has challenged the appropriateness and universal application of (the less than) 2500 gram low birth weight threshold. Their account begins with Durham, Jenss and Christie's (1939) study which investigated the influence of race and sex on the growth and development of infants. Durham et al. (1939) found Black infants presented with twice the number of White infants under the low birth weight threshold of 2500 grams. This prompted them to question the general application of the low birth weight threshold and the justification of its use.

Secondly, Wilcox and Russell (1990) refer to the study conducted by Anderson, Brown and Lyon (1943). Their findings were similar to those found in Durham et al.'s (1939) study. In Anderson and Brown's (1943) examination into the causes of prematurity, particularly the effect of race and sex on the length of gestation and birth weight, they found significant race and sex differences between Black and White infants, prompting their recommendation for separate population weight standards to be used.

Wilcox and Russell (1990) then refer to several other studies which have also questioned the use of the standard low birth weight criteria and, like the previous studies they have alluded to, have also received little recognition for their practical application and usefulness in identifying potentially at risk infants using population specific birth weight standards (Brown, Lyon & Anderson, 1945; Davies, Senior, Cole, Blass & Simpson, 1982). Nonetheless it was an alternative criterion proposed by Gösta Rooth (1980), who recommended that each population derive their own separate low birth weight criterion based on their respective birth weight distributions, which Wilcox and Russell (1990) strongly endorsed as a better measure of identifying higher risk infants within and between specific populations.

However, a decade later, Wilcox (2001), in a controversial commentary debating the causal relationship between birth weight and health outcomes, dismissed the low birth weight category, calling it an unreliable predictor of population risk. Building on his earlier recommendations for the use of standardised birth weight distributions

coupled with their associated weight specific mortality rates, when determining true mortality rates between two distinct populations, Wilcox (2001) argued that the frequency distribution of birth weight fits that of a normal bell-shaped curve and consists of two components, the predominant and residual distributions. The predominant describes the area that falls within and below the bell-shaped curve and is directly likened to represent the term births within a population. The residual distribution is all those births that fall outside the predominant distribution and within the lower tail of the curve. Births within the residual distribution are virtually all small, preterm and at higher risk of infant mortality. Using these two components, Wilcox (2001) illustrates how low birth weight, specifically the percentage of low birth weight within a population is an unreliable indicator of perinatal risk. In this context, the low birth weight criterion of 2500 grams would include all those births within the residual distribution plus a portion from the predominant distribution. Thus an increase of births within the residual distribution, where infants are deemed as most at risk, would increase the low birth weight percentage. Similarly, a decrease of the mean birth weight within the predominant distribution, or an increase in standard deviation would also increase the percentage of low birth weight infants. This, Wilcox (2001) suggests is why the percentage of low birth weight as a predictor of perinatal risk within populations is insufficient.

Although Wilcox (2001) poses a strong argument against the use and application of the low birth weight threshold, he fails to recognise its value. Unlike Wilcox (2001), the international community acknowledges its usefulness in identifying at risk populations. Evidence of this comes from the copious amount of epidemiological studies and health research that continues to use low birth weight as an indicator of ill health. At present, individual countries are developing their own population specific measures as is the case in Aotearoa New Zealand, where McCowan and Stewart (2004) have developed a customised centile calculator to determine various birth weight centiles within a multicultural Aotearoa New Zealand population. The same can be said of Australia where public health researchers have developed their own centile measures (Mongelli, Figueras, Francis & Gardosi, 2007). The current study acknowledges the limitations of the standard low birth weight threshold and its relevance in today's ever changing

society. The present study also recognises the usefulness of low birth weight when determined by the 10<sup>th</sup> percentile within specific populations as opposed to its absolute measure of <2500 grams.

## **2.5 Pacific and Samoan birth weight characteristics**

Many studies have found that Pacific infants are significantly heavier at birth than infants from other ethnic groups (McCowan & Stewart, 2004; McCowan, Stewart, Francis & Gardosi, 2004). A study conducted in 2004 found that the average birth weight for infants born to Pacific mothers was 3540 grams, 110 grams heavier than the average birth weight of infants born to New Zealand European mothers (McCowan & Stewart, 2004). Consequently, the rate of Pacific infants born of low birth weight (<2500 grams) is comparatively low. In 2001, the rate of low birth weight for Pacific infants was 4.5 per 100 live singleton births, compared to the national rate of 6.3 per 100 live singleton births (Ministry of Health & Ministry of Pacific Island Affairs, 2004). Despite being less likely to be of low birth weight, Pacific infants are more likely to die during infancy (Ministry of Health & Ministry of Pacific Island Affairs, 2004). This is unexpected given that low birth weight is strongly associated with infant mortality. The definition of low birth weight was established from clinical practice and research on primarily European populations and may therefore be inappropriate for Pacific populations. Given that Pacific infants are on average heavier at birth than their European counterparts, the standard definition of low birth weight (<2500 grams) may “under diagnose foetal growth restriction in Pacific Island babies” (McCowan & Stewart, 2004, p. 432). As such, the implications caused by using an inappropriate low birth weight threshold may contribute to the higher rate of infant mortality that Pacific people experience in Aotearoa New Zealand compared to the general Aotearoa New Zealand population. The current research examines whether there are differences in birth weight between Samoan infants born in Samoa compared to Samoan infants born in Aotearoa New Zealand.

Ethnic differences in the incidence of infant mortality also exist in Aotearoa New Zealand (Gao et al., 2006; Ministry of Health & Ministry of Pacific Island Affairs, 2005), with Pacific people having a relatively higher incidence of infant mortality than other ethnic groups. Given the higher prevalence of Pacific infant mortality, and the health related socioeconomic disparities that exist within Aotearoa New Zealand’s ethnic groups (Sundborn, 2007), it is important to determine what factors give rise to this occurrence. Understanding causal factors will help to identify ways to reduce incidence



and improve infant health as well as the health and social wellbeing of the people it affects.

This section addressed the issue of why Pacific infants have a higher infant mortality by firstly reviewing factors associated with infant mortality. Following this was a focus on birth weight as low birth weight is a primary risk factor of infant mortality. Subsequently, a case will be put forward for having a Pacific-specific low birth weight threshold. Finally, it will outline the brief demographics of the two countries from which the current research draws its comparative samples – Aotearoa New Zealand and Samoa – to examine whether there is a need for a Pacific-specific low birth weight threshold.

### **2.5.1 A case for having a Pacific-specific low birth weight threshold**

Internationally, ethnic differences in infant mortality have been observed. Much of this work has been done in the United States, largely looking into the differences between Black, White and Hispanic ethnic groups (Hummer et al., 1999). Ethnic differences also exist in Aotearoa New Zealand, a largely multicultural society (Gao et al., 2006). Pacific babies born in Aotearoa New Zealand have a 40% greater risk of death during infancy than the average Aotearoa New Zealand baby (Ministry of Health & Ministry of Pacific Island Affairs, 2004). Although Pacific babies have a lower prevalence of pre-term and low birth weight deliveries compared to other Aotearoa New Zealanders, infant mortality remains higher for Pacific people, and has been increasing since 1997 (Gao et al., 2006). Because birth weight and more accurately low birth weight is strongly associated with infant mortality, it is important to consider the definition of low birth weight and whether an ethnic specific low birth weight threshold would better identify at risk Pacific infants.

The Pacific Island population in Aotearoa New Zealand is more youthful than the general Aotearoa New Zealand population (with the median age being 21 years), and comprises 6.5% of the total population, and projected to grow to 12% of the Aotearoa New Zealand population by the year 2051 (Gao et al., 2006; Statistics New Zealand Census, 2001a). For these reasons it is important to consider the role that low birth

weight has on infant mortality in order to contribute to improving Pacific health and therefore Aotearoa New Zealand's health outcomes.

As outlined previously, Pacific babies tend to be significantly heavier than other ethnic groups (McCowan & Stewart, 2004; McCowan et al., 2004) and yet, are more likely to die in infancy relative to other ethnic groups (Ministry of Health & Ministry of Pacific Island Affairs, 2004). This paradoxical finding highlights the need for a Pacific-specific low birth weight threshold. Recently, attention has been given to this need. Using a cohort of 1398 Pacific babies gathered from the PIF study, Sundborn (2007) analysed each Pacific ethnic group's average birth weight and suggested that a low birth weight threshold of <3000 grams be used instead of the common threshold of <2500 grams. Primary information such as antenatal care, maternal health, and lifestyle behaviours were sought from the infants' mothers with additional birth outcome data being sourced from Plunket and hospital records after receipt of full informed consent. The data was analysed using standardised instruments. Sundborn's (2007) analyses indicated that both Samoan and Tongan infants were larger than their Aotearoa New Zealand European counterparts whose birth weights appeared more comparable with Cook Island and Niuean infants. From these findings, combined with the high prevalence of infant mortality and premature complications in Pacific infants, Sundborn (2007) proposed a re-definition of the current standard low birth weight measure to better identify high risk Pacific infants.

The present research builds on Sundborn's (2007) study, aiming to investigate whether the current standard measure used to determine low birth weight (<2500 grams as determined by the 10<sup>th</sup> percentile of full term births) is appropriate for Pacific infants or whether the ethnic-specific low birth weight measure of <3000 grams proposed by Sundborn (2007) is more apt at identifying high risk Pacific infants.

## Chapter 3 - Study aims and Objectives

This chapter presents the study aims, the overarching research statement and key study objectives.

### 3.1 Study aim

The aim of this project is to investigate whether the current standard used to determine low birth weight (low birth weight<sup>1</sup> <2500g) is appropriate for Samoan infants or whether a higher threshold is more appropriate.

### 3.2 Research statement

Samoan infants born in Samoa will have comparable average birth weight and the 10<sup>th</sup> percentile of birth weight (used to define low birth weight) compared to Samoan infants born in Aotearoa New Zealand (from the Pacific Islands Families Study).

### 3.3 Objectives

The objectives of the study have been determined by the data available for comparison between the two Samoan populations

The key objectives are as follows:

- to determine whether the distribution of low birth weight infants among Pacific Island infants of Samoan descent born in Aotearoa New Zealand are comparable with Samoan infants born in Samoa using the current low birth weight threshold (<2500 gms).
- to determine whether healthy full-term<sup>2\*</sup>, singleton Samoan infants born in Aotearoa New Zealand, have similar average birth weight measures and birth weight distributions compared to healthy full-term, singleton Samoan infants born in Samoa.

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<sup>1</sup> This low birth weight threshold is determined by the 10<sup>th</sup> percentile of full term births.

<sup>2</sup> Full term is defined as the 37 to 40 weeks gestational period.

- to determine the birth weight distribution of these full-term, singleton Samoan infants born in Samoa and Aotearoa New Zealand respectively and whether they are comparable using percentile values ranging from minimum, 1%, 5%, 10%, 25%, 50% (median), 75%, 90%, 95%, 99% and maximum. Of particular interest is the 10<sup>th</sup> percentile for the two Samoan birth sample populations.
- to investigate whether selected socio-economic, demographic and biomedical factors have any bearing or impact on birth weight.
- to establish a working relationship with the National University of Samoa (NUS) for future collaboration on research that will benefit the health outcomes of all (indigenous and migrant) Samoans.

## **Chapter 4 - Methods**

### **4.1 Target population**

The target populations of this study are Samoan mothers and their infants born in two distinct locations, specifically Samoa Islands and Aotearoa New Zealand. The research will examine these populations for the birthing years 2006 and 2000 respectively. The Samoan born sample for this project was sourced from the birth registrations with the Samoan National Hospital – Tupua Tamasese Meaole (TTM) between the years 2005 to 2006. While the comparative sample of New Zealand born Samoans was sourced from the Auckland Pacific Island Families (PIF) Study for the year 2000.

### **4.2 Design**

An international comparative cross-sectional study design is employed for the present study. Cross-sectional study designs are often the simplest way of gathering health-related information and other associated factors about a specific population sample at a particular time (Public Health Encyclopaedia, 2008). This design was employed to examine and compare the birth outcomes of low birth weight (<2500 grams) and preterm (<37 weeks gestation) births between Samoan mothers in New Zealand and Samoa, in relation to relevant maternal demographics and lifestyle characteristics such as mother's age, marital status, and parity along with other related factors available from the birth records of a Samoan born population sample. The decision to base comparisons on variables obtained from the Samoan born sample came in the planning stage of this research project, as it was anticipated that variables recorded within the Samoan born sample would to some extent differ and be limited in comparison to the variables recorded within a New Zealand birth cohort. As this is a comparative study of two distinct Samoan birth weight cohorts, specifically between Samoan infants born in Samoa and Samoan infants born in New Zealand, a detailed description of each cohort, sample size methods of data collection and the exclusion criteria for statistics analysis will follow correspondingly. In the case of the Samoan born cohort it is important to note that the methods of data collection for this

population sample were complex, thus the comprehensive account provided for this particular sample population is provided first within the procedures section.

### **4.3 Inclusion/exclusion criteria**

Due to their clear relationship to preterm and low birth weight (Blondel et al., 2002), infants from multiple births or extreme birth weights (600 and 650 grams respectively) are considered as outliers and were excluded. Also excluded were neonatal deaths and still births ( $n = 8$  and  $12$  for Samoan TTM dataset only; as the PIF dataset had already screened for these fatal birth outcomes, the exact figures were not available). Similarly, maternal relationship to baby was restricted to birth mothers only, and those who self identified as being of Samoan ethnicity. As mentioned above, the Samoan born sample population dictated the variables to be included. Thus birth weights, with corresponding gestational weeks estimated by the date of mothers' last menstrual period (LMP) were utilised as one of the measurement criteria in this study. While this is one of two commonly used methods to estimate the gestational age of an unborn child, it is considered less accurate than the preferred method of ultrasonography (Mongelli & Gardosi, 2010). The use of this method of measurement was determined by the variables documented in the Samoan TTM Hospital dataset from which only gestational estimates by LMP were available.

### **4.4 Instruments**

The primary outcome measurement is birth weights measured to the nearest 10 grams for Samoan infants born in Samoa and to the nearest 5 grams for Samoan infants born in Aotearoa New Zealand. These measurements were taken shortly after birth and recorded in the hospital's birthing records. Vital in determining eligibility is LMP. Maternal recall of LMP was taken from TTM Hospital records in Samoa and Middlemore Hospital records in Aotearoa New Zealand. Additional important variables including maternal and infant characteristics were obtained from TTM medial birth hospital records in Samoa and Middlemore Hospital birth records and Plunket in Aotearoa New Zealand. The variables included were mother's age, marital status, parity, sex of baby, twin member, delivery method and mother's smoking behaviour prior to conception.

## **4.5 Procedures**

### **4.5.1 Precautionary tales for the Samoan researcher in Samoa**

A distinguishing feature of this study is the birth weight data from a Samoan born sample population. A narrative of how the data was obtained offers insight into how research is conducted in Samoa. There are several pitfalls that await the unwary researcher; however these traps can be avoided by the strategic utilisation of cultural intermediaries. These are people who are immersed or familiar with *vā* interrelations and who are willing to use their *vā* relations on the behalf of the researcher.

### **4.5.2 Initial request for Samoa data**

The narrative begins in May 2009 when an initial request was made to the Samoan Ministry of Health (MOH); specifically a formal email request to the assisting chief executive officer (ACEO) of Strategic Development and Planning Division. The intention of this initial correspondence was to introduce the research topic and the research team, specifically the Master's student who would undertake the research and the supervisor who would oversee the entire project. It was anticipated to provide the Samoa MOH with a brief description of the research topic's purpose, rationale and more importantly an opportunity to work collaboratively within the area of child health. However, there was no response to this initial request.

Acting on the advice of a supervisor, a second request was sent out the following month (June 2009) to a personal contact of the supervisor in Samoa. Again the details of the intended research were offered in the email proper including details of the Auckland PIF study ( $n = 1398$ ) from which the comparative sample of Samoan infants ( $n = 650$ ) would be sourced. However, like the original request, there was no response from Samoa.

### **4.5.3 A chance encounter proves fruitful**

It soon became apparent that avenues taken by the principal research team to gain access and to form contacts with the primary target population in Samoa were futile. A

new strategy was needed in order for the research topic to take flight and gain momentum. It was a chance encounter in August 2009 with Dr Juliet Boon Nanai, who at the time was a Pasifika Academic Student Support Lecturer with Te Tari Awhina, The Learning Development Centre at the AUT University Akoranga Campus, which led to an informal conversation regarding the student researcher's topic. Dr Nanai provided insightful information on how one should conduct any research within Samoa. Essentially, Dr Nanai provided invaluable information as to the protocols for conducting research in Samoa. Particularly, as Dr Nanai so nonchalantly revealed, she had been the former Manager of Research and Development at the National University of Samoa (NUS). Furthermore, Dr Nanai authored the original protocol for conducting research within Samoa. She lobbied for it to be mandatory for any researcher(s) and research team, particularly those from outside of Samoa who want to research any facet of Samoa, its people, culture and place, to be bound by the law to return to Samoa and present their findings back to the people of Samoa. Table 4.1 provides an overview of the formal process of conducting research within Samoa. The mandate provided an ethically bound blueprint to utilise culturally appropriate methods which was intended to safeguard against unfounded claims and findings that were often made about Samoans by research team(s) and researchers. These researchers, having gained access to information which satisfied the parameters of their own research, often felt no responsibility to disseminate to the very people about whom, they are making claims (J. Nanai, personal communication, August 7, 2009). It was from this chance encounter that the project gained momentum, for now there was an explicit understanding of official protocols that the research team had to satisfy.

#### **4.5.4 Research protocols for Samoa**

Having established that any research intended for Samoa must adhere to explicit protocols stipulated by the Samoa Government, the next phase was to seek ethical approval from the relevant institutions in the host country. This provided the much needed insight required to advance the proposed research project. Similarly the protocol was welcomed by the Master's student as it not only provided a clear



framework for the student to work within, but it also provided a culturally appropriate approach that not only guides ethical practice, but is valued by the student.

To this researcher, the informal meeting with Dr Nanai highlighted the importance of adhering to the Samoan research protocols. By gaining 'ethical approval' from appropriate Samoan officials, the research would then be able to withstand the opposition and criticism, which is often encountered when the researcher(s) and/or research team come through 'the backdoor'. However, the use of Samoan social *vā* relations, are not a way of avoiding bureaucratic red tape, but instead enable smooth passage through bureaucratic obstacles, but this depends on how well connected is the intermediary.

**Table 4.1.** Guidelines for conducting culturally appropriate health research in Samoa  
**Protocols for health research in Samoa**

Research intended for Samoa should adhere to the following protocol

- Intended researcher and/or team of researchers are required to submit a formal research application through their institution to the Samoa Ministry of Health.
- Intended researcher and/or team of researchers are also required to send a complete copy of their research proposal to the Samoan Ministry of Prime Minister and Cabinet, in particular the Samoan Department Head: Auseugaefa Vaasatia Poloma Komiti.
- Intended researcher and/ or team of researchers are required to apply for an 'Academic Visa' from the Samoan Immigration Department. The estimated cost for an academic visa to undertake any research in Samoa ranges from \$500 to \$600 tala.
- Intended researcher and/ or team of researchers are also required to apply for ethics approval from the Samoan Ministry of Health and the University Research Ethics Committee at the National University of Samoa. The estimated cost for an ethics application to undertake any research in Samoa ranges from \$400 to \$600 tala respectively.
- It is mandatory for research findings from any research conducted within Samoa be disseminated in Samoa to the Samoan participants, officials and key stakeholders.

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Adapted from the National University of Samoa, Research application guidelines and Ministry of Prime Minister and Cabinet

#### **4.5.4.1 Vā relations are initiated**

The first official meeting between Dr Nanai and the Master's student (a week after the initial discussion) identified that the best way to request information from Samoa Government Departments was through the National University of Samoa (NUS), specifically through the Department of Development and Research. Dr Nanai offered to make the initial contact with the Samoan University. She called upon previous work

colleagues at the University to identify the appropriate paperwork required for the successful progression of the study within Samoa. In less than a day, Dr Nanai had received a response from the Manager of Research and Development at the National University of Samoa. The Manager's response provided a comprehensive breakdown of research fees, including Academic visas and ethical clearance, required from both the Samoan government and the University. This was the first official response, and it resulted from the researcher forming reciprocal social *vā* relations with appropriate cultural intermediaries namely Dr Nanai, who was willing to activate her social and professional *vā* networks for the researcher's ends.

#### **4.5.4.2 First attempt at obtaining Samoa sample**

A month later a two page proposal was compiled detailing the current research aims and objectives, background and rationale, methods of data collection and analysis (including an explicit description of sample size and inclusion criteria) for birth data from the year January 2006 to January 2007. Simultaneously a tentative timeline for the proposed research topic was sent, via email, to the Manager of Research and Development at the National University of Samoa (NUS). In this proposal a dataset of 300 Samoan infants, where at least one parent identified as Samoan, was initially sought in Samoa. The Manager of Research and Development sent back the proposal with recommended amendments, namely the inclusion of Samoan literature and a statement as to the benefits of this particular research to the Samoan people. It was also strongly recommended that the student provide a Samoan translation of the intended research.

After the recommendations for amendments were received, there were unfortunate delays to the production of an acceptable final proposal. Firstly, the amendments took longer than anticipated. Samoan literature specifically on current Samoa health statistics was scarce, particularly printed information, though limited health data was also available online. It was also difficult to translate the proposal into formal Samoan. Furthermore, it was during this period of locating resources and making the recommended changes that a massive Tsunami hit Samoa, causing widespread devastation and massive loss of life with a reported death toll of 129 with 10 people

unaccounted for along the Southern coastline of Samoa. Substantial damage and loss of life was also experienced in neighbouring Islands such as Tonga and American Samoa. This event would forever haunt the people of Samoa, holiday-makers and the families worldwide who lost loved ones to the Samoan tsunami. The months to follow would signify a period of great uncertainty for surviving families, left with the massive task of rebuilding their lives, their homes and broken hearts. One such family who would endure hard times that lay ahead, having lost 14 members to the natural disaster was that of the NUS Manager of Research and Development. This would signify the largest loss of life experienced within one family. The Taufua Family not only lost loved ones but also their livelihood – the world renowned Taufua Beach Fales along Lalomanu village was devastated. The natural catastrophe caused significant delays with the proposed research intended for Samoa, as people in Samoa struggled to regain normalcy in their everyday lives.

#### **4.5.4.3 National University of Samoa approves ethics**

It was in February 2010 that Dr Nanai received word from the National University of Samoa (NUS) to confirm the successful acceptance of the present research topic by the University Research Ethics Committee (UREC). Although normally a long and thorough process, this particular ethics approval was further prolonged by the tragic events of the past year. Unfortunately, this meant the Masters student had only two months in which to complete data collection, analysis and overall write up of thesis proper which was due for final submission in June, 2010. Upon approval plans were immediately made to fly to Samoa and collect the much needed birth weight data for comparative analysis.

A successful application to the prestigious Le Va awards that year was necessary to fund the trip. A complicating matter for arranging research in Samoa was the fact that the supervisor was a male and the student female. While not uncommon for female master's students to have male supervisors, Samoan custom has very strict behavioural protocols governing gender *vā* relations. The supervisor/student relationship would be regarded by the Samoans as analogous to uncle/niece relationship. This perception should not be taken lightly, as the relationship carries

reciprocal responsibilities. So certain actions may be interpreted as inappropriate to the '*social or va*' relations by which the wider society view the pairing of student/supervisor as having. There was a need for a cultural intermediary to advise on cultural appropriateness in terms of gender issues, particularly as the supervisor and student are not usually family members.

#### **4.5.5 Samoa trip goes ahead**

To circumvent this important issue, the student was chaperoned by her mother who had organised accommodation with family in Samoa. The mother also arranged for the supervisor to be housed with her family. It was through these family connections that eventually allowed for the successful retrieval of birth weight data from Samoa's National Hospital - the Tupua Tamasesee Meaole Hospital in Motootua, Apia. Upon arrival in Samoa, it soon became clear the massive amount of work that needed to be accomplished within four days, the time allocated for Samoan data collection. The original rationale for the short visit was to identify the likelihood of gaining future access to the birth weight data and accompanying records, as ethics approval was still required from the Samoa MOH. It was anticipated that within our four day stay, there would be a clear indication from the Samoan MOH as to a timeframe for ethics approval and the subsequent data collection would be realised, as several enquires made by the supervisor to the MOH had been unanswered. On a positive note, it would be an opportunity to meet face to face with the Samoan counterparts, those working behind the scenes to progress the research through such as members of the University Research Ethics Committee and key Samoan MOH officials.

##### **4.5.5.1 Kinship *vā* networks are activated in Samoa**

Prior to our arrival in Samoa, unbeknownst to the student and supervisor, the student's mother had initiated her Samoa networks from Aotearoa New Zealand and enlisted the help of her niece Roina Vāvātau, in Samoa. It would be through these kinship ties that the research team would see the advancement of the current research in Samoa. 'Aunty' Roina initiated her social and professional '*vā*' within Samoa to kick start the research. Literally, within an hour of touching down in Samoa, Roina had simultaneously set up an appointments to meet with the ACEO of Strategic

Development and Planning Division within the Samoa MOH, similar appointments were made to meet with key stakeholders within NUS such as Director for the Centre of Pacific studies, Manager of Research and Development and members of the UREC committee. Furthermore Roina organised the purchase of a mobile phone and a rental car for the supervisor to use during the four day trip. The mobile phone and car were absolutely necessary for prompt and efficient work within the brief four day stay. By nightfall that same day, Aunty Roina had, within the space of an hour, successfully organised key meetings for the visiting research team, something which they were unable to set up from New Zealand. Therefore kinship *vā* enabled access to social and professional networks which helped to facilitate the smooth engagement with key informants.

#### **4.5.5.2 Kinship *vā* as cultural intermediary**

On day one in Samoa, testament to family ties being the strongest *vā*, 'Uncle' Vāvātau Taufao would accompany the student and supervisor to the Samoa MOH office in Motootua. Although an extremely busy man, Vāvātau offered his invaluable time to assist the student and supervisor in their quest for ethics approval for the current study, similarly by meeting with key MOH officials it would provide insight into the progress of the student's ethics application and whether data collection could begin. The meeting with MOH was preceded by Vāvātau introducing the student and supervisor to key NUS staff and UREC committee members who had been instrumental in approving the current study in Samoa. Nevertheless, the highly anticipated meeting with the MOH strategic and development planning ACEO was cancelled, Vāvātau enquired into the progress of the student's application and the likelihood of getting the required data within the next three days. The response was optimistic with an ending remark that the student should receive word of the outcome of her application by the end of the day. However Vāvātau did not take any chances. To make certain that he had exhausted every possible avenue, he decided a visit to the neighbouring National Hospital – Tupua Tamasese Meaole, to see if they could facilitate faster the data collection of the present study. Coincidentally, it was during this informal meeting with a senior staff member at the TTM Hospital that a phone call was received from Samoa MOH. The personal assistant to ACEO informed the student's supervisor that

ethics and the obtaining of birth weight data and other relevant information had been approved. Again this exemplifies the importance of kinship *va*. The strongest social bonds in Samoa are those of family. Moreover, it highlights the importance of having a cultural intermediary that is well respected and well connected within the community.

#### **4.5.5.3 Samoa Ministry of Health approves research**

By day two of the Samoan trip, verbal confirmation from the Samoa MOH regarding the ethics application approval was received. Also, the birth weight data was being collated by the MOH statistician and would be ready for pick up the following day. It was also during the telephone conversation (between the student's supervisor and personal assistant to ACEO) that the details of variables to be included in the Samoan birth weight dataset were discussed. Furthermore, an official meeting time was arranged for the student researcher to meet with the current ACEO of Strategic Development and Planning Division within the Samoa MOH. The meeting was to corroborate the approved status of the current research project to be undertaken within Samoa. The aim firstly was to sign contract agreements between the two parties, i.e. the visiting research team and the hosting country, and secondly, to allow the Samoa MOH to go over the terms and conditions of the contract and the timeframe for which the academic visa and ethics approval was allocated for both the student researcher and the accompanying supervisor. The trip proved to be more fruitful than anticipated especially considering the tight timeframe of the trip. The success of this particular research project can only be credited to the willing participation of various Samoan professionals and leaders, including and more pertinent family members who acted as cultural intermediaries to facilitate access to information in Samoa. This is not to imply that *vā* relations override bureaucracy but instead should be integrated and respectfully observed by the researcher(s) and research teams when conducting research in Samoa.

#### **4.5.6 The Samoa National Hospital – Tupua Tamasese Meaole (TTM)**

The final Samoan birth weight dataset was sourced from the Samoa National Hospital – Tupua Tamasese Meaole (TTM) Hospital located at Motootua in the capital. The sole teaching hospital in Samoa, TTM Hospital is also headquarters to the Samoa MOH.

TTM services include primary, secondary and tertiary care to its constituents. Similarly as the regional referral hospital for rural Upolu including Savaii, TTM provides specialist medical services (such as paediatrics, obstetrics / gynecology and surgery) through outreach clinics to District Hospitals (throughout Upolu) and Malietoa Tanumafili II Hospital in Savaii. The dataset for the present study included mothers who self identified as Samoan and were the infants' birth mother. In the case of the Samoan TTM dataset, it was assumed that the mothers were also Samoan as anecdotal evidence suggests that expectant mothers who are foreign born and/or financially secure are more likely than their Samoan born and financially uncertain counterparts to either return to their homelands to have their babies or opt to birth their newborns in private Samoan hospitals (L. Matalavea, personal communication, 23 April, 2010). Birth weight data and other additional information were sourced from birthing and maternal records held on TTM Hospital computerised database from which the final dataset was compiled from. The original dataset consisted of 1085 randomly selected birth registrations for the year 2005 to 2006. It included twins ( $n = 24$ ), neonatal deaths ( $n = 8$ ), including stillbirths ( $n = 12$ ), and one extremely small birth weight of 600 grams. The final numbers used for statistical analysis were restricted to single live births with birth weights measured to the nearest 10 grams ( $n = 1042$ ).

#### **4.5.7 The Pacific Island Families (PIF) Study**

The comparative sample of New Zealand born Samoans for this project was sourced from a larger longitudinal birth study known as the Pacific Island Families (PIF) Study. It commenced in 2000 in response to the increasing number of Pacific people experiencing adverse health and social outcomes which prompted the birth of the PIF study. This was a collaborative initiative by Pacific communities, leaders, researchers and vested health and social agencies to address the escalating rates of Pacific people presenting with avoidable disease (communicable and non communicable) (Statistics NZ, 2002; Ministry of Health, 2005; Ministry of Health, 2005), hospitalisation and death. In total, 1398 Pacific infants and their mothers were recruited from Middlemore Hospital from the 15 March to 17 December 2000. One of the largest teaching hospitals in New Zealand, Middlemore is the largest hospital under the Counties



Manukau District Health Board umbrella. It provides secondary level care and a select range of community and domiciliary services to the constituents within the Counties Manukau area (Healthpoint, 2010). Correspondingly the hospital also provides specialist tertiary services (such as spinal injury rehabilitation, orthopaedic and plastic surgery, burns, renal dialysis and neonatal intensive care) to consumers both regionally and nationally (Healthpoint, 2010). Of particular interest is its maternity division which delivers the largest number of Pacific births in New Zealand, representative of the main Pacific Island ethnic groups. There are also three other smaller maternity units (Botany Downs, Papakura and Pukekohe) within the Counties Manukau area which are connected to Middlemore hospital. These units provide primary maternity care to low risk pregnancies with only those high risk pregnancies requiring specialist care recommended to attend the main birthing unit at Middlemore. Births that had occurred at the main hospital but were then transferred to these community units, specifically Botany Downs and Papakura in the year 2000 were also eligible for the PIF study proper (Paterson et al., 2002; Paterson et al., 2004; Sundborn, Schluter, Schmidt-Uili & Paterson, 2010). Eligibility into the study required that at least one parent identified as having Pacific Island ethnicity and had New Zealand permanent residency status. Those mothers identified as potential participants were approached by an appointed Pacific liaison officer who provided them with a brief about the study and their permission to be revisited in six weeks. At the time of the six week postpartum visit, potential participants had been assigned a trained Pacific female interviewer whose responsibility was to provide participants with a full description of the intended study and gain informed consent from parents for the six week interview proper. Having gained informed consent interviews proceeded in the participants preferred language. In addition, information was sought from hospital records and postnatal information from Plunket. Essentially, these sources would provide the birth weight data and maternal characteristics pertinent to the present study, specifically the Samoan birth cohort of the study. Like the Samoan born cohort, the final numbers for the New Zealand born Samoan sample for comparative statistical analysis is also restricted to single live births, with birth weights measured to the nearest 5 grams (n = 647).

## 4.6 Statistical methods

Preliminary analyses to explore bivariate relationships used measures of association appropriate for scale and measurement of the variables. A cross tabulation of the explanatory variables was used to provide a descriptive overview of their distribution within the two sample populations. Similarly, tests of significance for the association were Fisher's exact test. The variables were: mother's age, marital status, parity, sex of baby, twin, delivery method, and mother's smoking habits prior to conception. Mother's age was categorised into four groups: less than 20 years (<20), between 20 and 29 years (20 – 29) also the reference group, between 30 and 39 years (30 – 39) and 40 and over (40+). Marital status was categorised into three groups: (1) married (reference) (2) de facto and (3) single. Maternal characteristics included: four categories of parity: 1, 2–3 (reference), 4–5 and 6+, five categories indicating infant's delivery method: (1) Normal delivery method (reference), (2) Elective caesarean section, (3) Emergency caesarean section (4) Other which consists of forceps, vacuum and ventouse deliveries and (5) Unknown delivery methods, and finally three categories indicating the tobacco use prior to conception (1) No (2) yes and (3) unknown. Subsequent bivariate association between birth sample populations and outcome variables were also explored using Fisher's exact test, while differences between two sample populations mean birth weights were determined using Student's t-test.

Successive multivariable analyses were performed using full term singleton births only with mean birth weight calculated at reference categories (mother's age 20-29 years, married marital status, primiparous, non smoker and for a female infant). The strength of association was estimated using odds ratios (OR) with corresponding 95% confidence intervals (CI). All explanatory variables except method of delivery were considered for adjustment. While concluding multivariable association between predictor variables and outcome variables were examined using binary generalised estimating equation (GEE) models, approximated by odds ratio and associated 95% CI, with the Samoan TTM sample population as the reference group. Preliminary analyses were implemented using SAS version 9.2 (SAS Institute Inc., Cary, NC, USA) while

multivariable analyses were performed using Stata version 10.0 (StataCorp, College Station, Texas).

## **4.7 Ethics**

### **4.7.1 Samoa TTM dataset**

Ethics approval for the Samoan born sample population was initially obtained from the University Research Ethics Committee at the National University of Samoa. Due to a memorandum of understanding (MOU) between the National University of Samoa and Auckland University of Technology, the ethics application fee of \$600 tala was waived. An additional ethics approval was obtained from the Samoa MOH who in good faith recognising the delays experienced by both the office and student (due to unforeseen circumstances of the past year) waived the costs of the academic visa of \$600 tala payable to the Prime Minister's office.

### **4.7.2 Auckland PIF study dataset**

Ethics approval for the larger PIF longitudinal study was obtained from the Auckland Branch of the National Ethics Committee and covers every data collection phase of the study. Correspondingly, endorsement was received from the Royal New Zealand Plunket Society and the South Auckland Health Clinical board (Paterson et al., 2002; Paterson et al., 2004; Paterson et al., 2006; Paterson et al., 2008; Sundborn et al., 2010). As the present study only requires the use of secondary data from the larger PIF study, additional ethics approval was not required. Nevertheless permission for the use of specific data such as birth weights and relevant maternal characteristics was obtained from the Directors of the PIF study facilitated by the PIF Data manager.

## Chapter 5 - Results

The statistical analyses for the two Samoan birth weight datasets are presented below. The first dataset consists of Samoan babies born in Samoa in the year 2006; a sample of 1,085 taken from the Samoan Tupua Tamasese Meaole (TTM) hospital. The comparative dataset consists of Samoan babies born in Auckland Aotearoa New Zealand's Middlemore Hospital in 2000; the sample of 656 babies in this dataset makes up the Samoan component of Pacific participants in the Pacific Island Families (PIF) Study. The numbers used in initial descriptive statistics for both sample populations include one member from a multiple birth. Overall, 1,052 Samoan TTM mothers gave birth to 1,066 live infants including 24 twins (one twin pair was stillborn), while 647 Samoan PIF mothers gave birth to 656 live infants including 18 twins. The numbers employed for subsequent data analyses would vary slightly from those previously used as distinct parameters were placed on both datasets to allow for like comparisons. For example, both datasets used in subsequent analyses included only Samoan birth mothers and live singleton infants. Therefore the final numbers used in subsequent statistical analyses for each birth sample population are 1,042 Samoan TTM and 641 Auckland PIF mothers of which 1,034 (99%) of TTM and 576 (90%) of PIF delivered term ( $\geq 37$  weeks gestation) infants.

### 5.1 Maternal and infant characteristics of the two birth samples

The maternal and infant characteristics of the two Samoan samples are presented in Table 5.1. Mothers from the Samoan TTM Hospital were mostly aged between 20 and 29 years, with an average age of 27 years ( $SD = 6.6$ ), with just over half of the sample population married. Also, these mothers had a median of two children ( $Q_1=1$ ,  $Q_3=4$ ) and 116 (11.0%) had more than six children. Furthermore, the majority of the mothers gave birth via normal vaginal delivery, otherwise referred to as spontaneous, and tended not to have smoked prior to conception. In comparison, mothers from the Auckland PIF study have similar maternal characteristics as their Island born counterparts. They too were mostly aged between 20 and 29 years, but had a slightly older average age of 28 years ( $SD = 6.0$ ; *Student's t-test*  $p < 0.001$ ). Like their TTM counterparts, the majority were married, and had a median of two children ( $Q_1=1$ ,

Q<sub>3</sub>=4). The PIF study mothers were also more likely to have had a normal vaginal birth compared to other modes of delivery, but unlike their Island born counterparts, were more likely to have smoked prior to conceiving.

**Table 5.1.**

*Maternal and infant characteristics of two distinct birth cohorts of Samoan mothers from the Auckland PIF study (n = 664) and Samoan TTM Hospital (n = 1,054)*

	PIF		TTM		
	Participants				
	n	(%)	n	(%)	p-value
<b>Mother's age (years)</b>					<0.001
<20	36	(5.6)	102	(9.7)	
20 - 29 years	344	(53.2)	591	(56.2)	
30 - 39 years	242	(37.4)	300	(28.5)	
40+	25	(3.9)	59	(5.6)	
<b>Mother's marital status</b>					0.09
Married	404	(62.4)	607	(57.7)	
De facto	125	(19.3)	247	(23.5)	
Single	118	(18.2)	198	(18.8)	
<b>Parity</b>					<0.001
1	178	(28.0)	329	(31.2)	
2 – 3	296	(46.5)	374	(35.5)	
4 – 5	122	(19.2)	235	(22.3)	
6 +	40	(6.3)	116	(11.0)	
<b>Sex of baby</b>					0.40
Female	313	(48.4)	487	(46.2)	
Male	334	(51.6)	567	(53.8)	
<b>Twin</b>					0.51
No	637	(98.5)	1,042	(98.9)	
Yes	10	(1.6)	12	(1.1)	
<b>Delivery method</b>					<0.001
Normal Vagina Delivery	501	(77.4)	940	(89.2)	
Elective CS	33	(5.1)	36	(3.4)	
Emergency CS	65	(10.1)	69	(6.6)	
Other	37	(5.7)	9	(0.9)	
Unknown	11	(1.7)	0	(0.0)	
<b>Smoker</b>					<0.001
No	497	(76.8)	980	(93.0)	
Yes	150	(23.2)	32	(3.0)	
Unknown	0	(0.0)	42	(4.0)	

## 5.2 Preterm and low birth weight

As the focus of the current research is to explore a case for a Pacific low birth weight (LBW) threshold it was only appropriate to begin with calculating the number of preterm (<37 weeks gestation) and LBW (<2500 grams) singleton births for the two Samoan samples. From Table 5.2 it is evident that the proportion of preterm births for the PIF study sample is almost ten times higher than that reported for the Samoan TTM group, with this marked difference between the two populations being statistically significant (*Fisher's exact test*  $p<0.001$ ). There was no important difference in the proportion of low birth weight newborns between the two birth samples. However there was a significant difference between the reported proportion of infants that were preterm and LBW for the two birth samples (*Fisher's exact test*  $p<0.001$ ). A combined total of 22 were both preterm and LBW with 15 from the PIF sample and 7 from the TTM sample.

**Table 5.2.**

*Proportion of preterm (<37 weeks gestation) and low birth weight (<2500 grams) singleton births for the Samoan TTM and PIF study.*

Birth sample	Gestation (weeks)		Birth weight (grams)	
	Total	Preterm(<37wk)	Total	LBW (<2500 gms)
	N	n (%)	N	n (%)
TTM	1042	8 (0.8)	1042	34 (3.3)
PIF	624 <sup>a</sup>	46 (7.4)	634 <sup>b</sup>	20 (3.2)

<sup>a</sup> Missing data = 13 (2.1%)

<sup>b</sup> Missing data = 3 (0.5%)

## 5.3 Mean birth weight and LBW for term births

Having already established the proportion of preterm and LBW infants within our two samples (Table 5.2), the following counts and proportions are calculated using term and low birth weight infants. The exclusion of preterm births and subsequent focus on full term births is done to allow for like comparisons and therefore more generalisable birth weight thresholds. From Table 5.3 the proportion of LBW infants within the Samoan TTM sample is 8 times that of the PIF sample, with strong evidence to suggest

a difference between the proportion of LBW full term births of the two samples (*Fisher's exact test*  $p < 0.001$ ). In the same way there is also strong evidence to suggest a difference between the term birth weights of our two samples (*Student's t-test*  $p < 0.001$ ). Overall the TTM sample has a significantly smaller mean birth weight compared to that of the PIF sample.

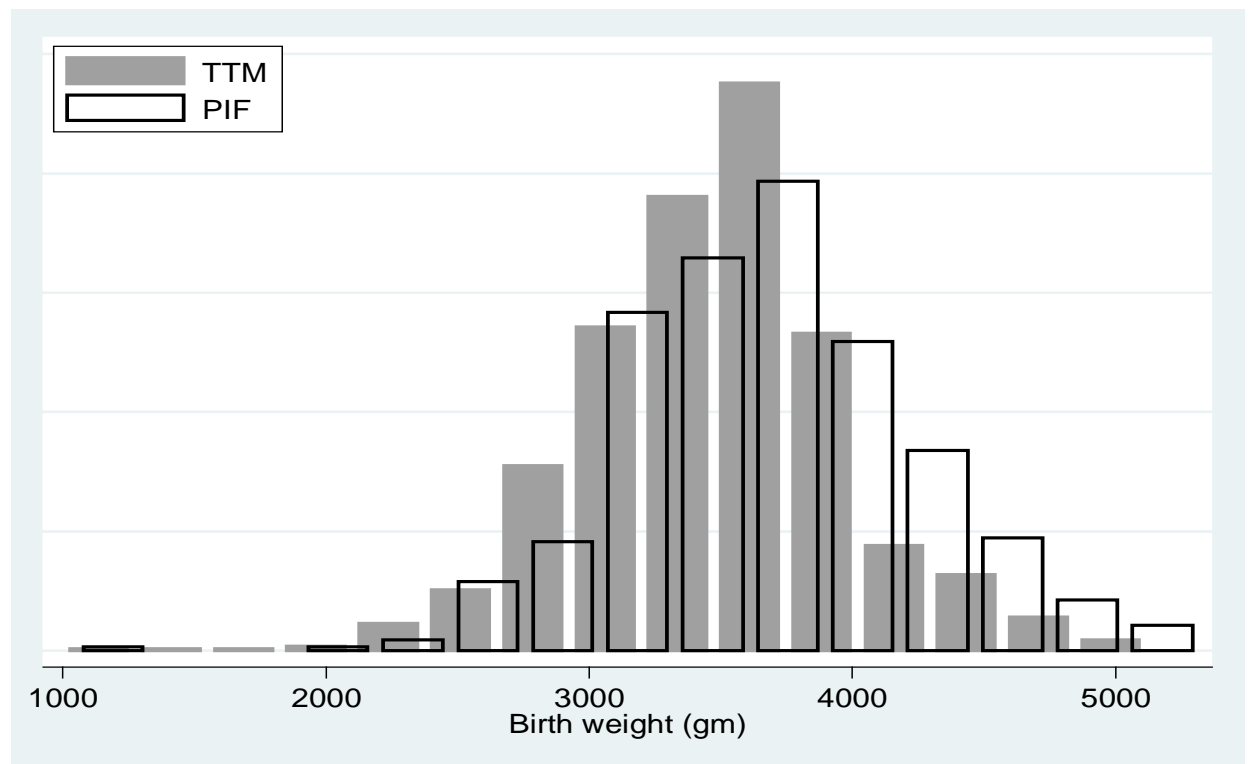
**Table 5.3.**

*Mean birth weight and proportions of low birth weight for full term (≥ 37 gestation weeks) singleton births for Samoan TTM and PIF study.*

Birth sample	Low birth weight (LBW)		Birth weight	
	Total N	LBW (<2500gms) n (%)	Mean	(SD)
TTM	1034	27 (2.5)	3453.2	(497.2)
PIF	576	5 (0.3)	3701.5	(551.3)

## 5.4 Distribution of birth weights for term births from the two birth samples

The superimposed histograms in Figure 5.1 display the birth weight distribution for term singleton births for the two birth weight samples. Compared with the PIF sample, the TTM birth weight distribution is shifted to the left, reporting more cases of relatively lower birth weights. These differences in term birth weights are further exemplified in Table 5.4, which provides percentile values for the two samples.



**Figure 5.1.** Histogram of the birth weight (gms) for term (gestation ≥ 37 weeks) singleton infants born to Samoan mothers in the TTM (n=1,033) samples and PIF (n=576).

The distribution of birth weight (gms) percentiles ranging from minimum, 1<sup>st</sup>, 5<sup>th</sup>, 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, 90<sup>th</sup>, 95<sup>th</sup> 99<sup>th</sup> and maximum for term singleton births for the two Samoan birth samples are displayed in Table 5.3. Compared to the PIF birth weight percentiles, the reported TTM birth weight percentiles were smaller at every percentile value considered, with differences ranging from 50 grams at the minimum value to 424 grams at the 99<sup>th</sup> percentile.



**Table 5.4.**

*Distribution of birth weight (gms) for term (gestation  $\geq 37$  weeks) singleton infants born to Samoan mothers in the PIF (n=576) and TTM (n=1,033) samples.*

Birth Sample			
Percentiles	PIF	TTM	Difference (PIF-TTM)
Minimum	1,050	1,000	50
1%	2,515	2,220	295
5%	2,790	2,700	90
10%	3,065	2,840	225
25%	3,320	3,210	110
50% (median)	3,683	3,480	203
75%	4,058	3,740	318
90%	4,427	4,040	387
95%	4,710	4,300	410
99%	5,164	4,740	424
Maximum	5,320	5,120	200

## 5.5 Exploring the variability in mean birth weights of term infants between samples

Having illustrated marked differences in the number of preterm and LBW infants between PIF and TTM term birth weights (Table 5.2), the significant differences in term birth weights (Tables 5.3 and 5.4, and Figure 5.1), a multivariable analyses was employed to explore the variability of mean birth weights of term singleton infants between the two samples and ascertain whether any of the available characteristics might explain this difference. Table 5.5 shows the mean birth weight and associated 95% confidence interval (95% CI) for the two samples. Also reported are the difference in means and associated 95% CI for crude and adjusted regression analyses. The crude analysis, presented in Table 5.5, was used to confirm whether the mean differences in birth weight was significantly different between the two birth samples, without considering any other factor. This model is statistically significant ( $p < 0.001$ ). So for every Samoan baby born in Samoa would expect on average to be 248 grams (95% CI: 196, 301) lighter than their Auckland born PIF counterparts. However, differences in the socio-demographic profiles were noted between the two samples in Table 5.1. To

ascertain whether the significant mean differences in birth weight between samples were moderated by these profile differences, the regression analyses were repeated adjusting for all the variables listed in Table 5.1, except for method of delivery. Again, the mean birth weights for both birth samples are significantly different ( $p < 0.001$ ) but the difference was slightly smaller than that from the crude analyses. After adjusting for potential confounding variables that were available, the adjusted model suggests that for every Samoan birth in Samoa would expect to be on average 234 grams (95% CI: 171, 290) lighter than those Samoan births in Aotearoa New Zealand. This multivariable regression analysis explained approximately 9% of the variability in birth weights. Thus, these differences observed within and between the two birth samples mean birth weights and associated 95% confidence intervals, suggests the presence of other important individual, cultural, societal and environmental factors are at play other than those already adjusted for in the model.

**Table 5.5.**

*Mean birth weight (gms) and associated 95% confidence interval (95% CI) for the PIF and TTM samples, together with the difference between means and (95% CI), for the crude and adjusted regression analyses.*

	Birth sample					
	PIF		TTM		Difference (PIF-TTM)	
	mean	(95% CI)	mean	(95% CI)	mean	(95% CI)
<b>Crude</b>	3,702	(3,659, 3,744)	3,453	(3,422, 3,485)	248	(196, 301)
<b>Adjusted*</b>	3,553	(3,479, 3,628)	3,319	(3,250, 3,388)	234	(171, 290)

\*Adjusted for all variables included in Table 1, except for method of delivery, with mean birth weights calculated at reference categories: mothers' age 20-29 years, married marital status, primiparous, non-smoker, and for a female infant.

## 5.6 Predictors of mean birth weight of term Infants

Two natural questions arise, namely: what predictor variables are associated with mean birth weight and are there significant differences in the effect of these predictor variables between PIF and TTM samples? Using a manual stepwise backwards elimination multivariable regression procedure of a fully saturated main effects (all variables listed in Table 5.1 except method of delivery) and interactions with these

main effect and sample type (PIF and TTM), the final parsimonious model of mean birth weights with associated 95% confidence intervals for the two birth samples that resulted is displayed in Table 5.6. This final model was used to determine which of the predictor variables in Table 5.1 were associated with mean birth weight and whether there were significant differences in the effect of these predictor variables between the two birth samples. Table 5.6 reports the mean birth weights across the significant variables: sample type ( $p<0.001$ ); maternal age categories ( $p<0.001$ ); parity ( $p<0.001$ ) and infant sex ( $p=0.05$ ). Interestingly marital status alone was not significantly related to mean birth weight levels, but there was a significant differential relationship of marital status on mean birth weight between the PIF and TTM samples (interaction  $p=0.02$ ). Also noteworthy, and counter-intuitive, is the non-significant result obtained for mothers smoking status prior to conceiving for the two birth samples.

**Table 5.6.**

*Mean birth weights (gms) with associated 95% confidence interval (95% CI) for all variables in the final parsimonious model calculated when all other significant variables were held at their reference level (mothers' age 20-29 years, married marital status, primiparous, non-smoker, and female infant).*

	Birth sample			
	PIF		TTM	
	mean	(95% CI)	mean	(95% CI)
<b>Age (years)</b>				
<20	3,580	(3,471, 3,689)	3,368	(3,265, 3,470)
20-29	3,538	(3,462, 3,614)	3,326	(3,255, 3,397)
30-39	3,661	(3,573, 3,749)	3,448	(3,363, 3,534)
40+	3,516	(3,375, 3,657)	3,304	(3,170, 3,437)
<b>Marital status</b>				
Married	3,538	(3,462, 3,614)	3,326	(3,255, 3,397)
De facto	3,584	(3,475, 3,693)	3,218	(3,136, 3,299)
Single	3,430	(3,321, 3,539)	3,284	(3,201, 3,367)
<b>Parity</b>				
Primiparous	3,538	(3,462, 3,614)	3,326	(3,255, 3,397)
Multiparous	3,678	(3,611, 3,745)	3,466	(3,408, 3,524)
<b>Infant sex</b>				
Female	3,538	(3,462, 3,614)	3,326	(3,255, 3,397)
Male	3,587	(3,511, 3,663)	3,375	(3,305, 3,445)

## 5.7 Exploring the variability in LBW and preterm infant patterns between samples

Now, considering all singleton births from Samoan mothers captured in the two samples, it is of interest to explore whether the differences in LBW and preterm patterns seen in the crude analysis are explained by differences in the variables seen in Table 5.1 between PIF and TTM samples. Given the relationship seen between LBW and preterm status, and their dichotomous status, binary generalised estimating equation (GEE) model analyses using robust estimators of variance were conducted to simultaneously explore this research question. Table 5.7 displays the crude and adjusted GEE model analyses of LBW and preterm indications and associated 95% confidence intervals separated for the two samples. From the crude analysis it can be

seen that the PIF sample has an odds of being 2.69 (95% CI: 1.70, 4.27) times as likely as the TTM sample to have a preterm and/or LBW infant. Moreover, the correlation between LBW and preterm status is moderate ( $\rho=0.36$ ). Comparable and also statistically significant are the adjusted odds ratio for the PIF sample. After adjusting for all variables in Table 5.1 except for method of delivery, the adjusted odds ratio for the PIF sample is consistent with previously reported counts and percentages in Table 5.3 showing PIF infants to be 2.56 (95% CI:1.55, 4.21) as likely to be preterm and/or LBW. These findings suggest the PIF birth sample is more likely than the TTM birth sample to be preterm and LBW for reasons that have not been captured by this study, as they are likely to relate to cultural, societal and environmental factors.

**Table 5.7.**

*Crude and adjusted generalised estimating equation (GEE) model analyses of LBW and preterm indications and associated 95% confidence interval (95% CI) for the PIF and TTM samples, assuming an exchangeable correlation structure and robust variance estimators, treating the TTM sample as the reference category.*

	TTM		PIF		p-value	Correlation ( $\rho$ )
	OR	(95% CI)	OR	(95% CI)		
<b>Crude</b>	1.00	(reference)	2.69	(1.70, 4.27)	<0.001	0.36
<b>Adjusted*</b>	1.00	(reference)	2.56	(1.55, 4.21)	<0.001	0.36

\*Adjusted for all variables included in Table 1, except for method of delivery, with odds ratios (ORs) calculated at reference categories: mothers' age 20-29 years, married marital status, primiparous, non-smoker, and for a female infant.

## 5.8 Predictors of LBW and preterm infants

Lastly, it is of interest to determine what predictor variables are associated with LBW and preterm deliveries, and whether there are significant differences in the effect of these predictor variables between PIF and TTM samples. Again, using a manual stepwise backwards elimination multivariable GEE procedure of a fully saturated main effects (all variables listed in Table 5.1 except method of delivery), and their interactions with sample type (PIF and TTM), a final parsimonious model was derived.

Table 5.8 presents the results of this final model analysis of LBW and preterm indications and associated 95% confidence intervals for the two birth samples. The final model identified a significant interaction between marital status and sample type ( $p=0.05$ ), a similar finding to that obtained using multivariable regression analyses of birth weight predictors. However unlike the birth weight predictors, which found marital status alone to be non-significant, the current analysis found marital status as a main effect to be statistically significant ( $p=0.02$ ) to preterm and/or LBW outcomes of the two birth samples. No other main effect or interaction terms were found to be significantly related to preterm and LBW outcomes. Compared to those married in the TTM sample, PIF mothers in de facto relationships have the highest odds of birthing a preterm and/or LBW infant. These results (and those in the previous section) are driven by the excess of preterm infants seen in the PIF study compared to the TTM sample (Table 5.2).

**Table 5.8.**

*Final, most parsimonious, generalised estimating equation (GEE) model analyses of LBW and preterm indications and associated 95% confidence interval (95% CI) for the PIF and TTM samples, assuming an exchangeable correlation structure and robust variance estimators, treating the TTM sample as the reference category.*

	Birth sample	
	PIF OR (95% CI)	TTM OR (95% CI)
<b><i>Marital status</i></b>		
Married	2.44 (1.29, 4.59)	1.00 (reference)
Defacto	4.88 (2.27, 10.52)	0.58 (0.21, 1.58)
Single	3.61 (1.62, 8.05)	2.36 (1.08, 5.14)

## Chapter 6 – Discussion

This chapter will discuss the findings and other points of interest that arose as a consequence of this study. The chapter begins with a discussion around the primary results: whether they address the primary research questions initially posed. This is closely followed by addressing whether there is a need for more Pacific research on birth outcomes such as birth weights and in particular low birth weight. Then an account of the student's experiences with collecting data from Samoa will be given, followed by an argument in favour of a low birth weight measure based on the birth weight distributions of specific populations is put forward. The chapter concludes with discussion around the strengths and limitations of the current study.

### 6.1 Primary results

The current research hypothesised that Samoans born in Samoa would have comparable average birth weights and 10<sup>th</sup> percentile birth weights with Samoans born in Aotearoa New Zealand. The overall findings of this study however suggests otherwise. The findings instead suggest that Samoan infants, after adjusting for the available predictor variables, would expect to be on average 234 grams lighter than Samoan infants born in Aotearoa New Zealand. Also significantly different were the 10<sup>th</sup> percentile birth weights between the two sample populations: PIF was 3,065 grams and TTM was 2,840 grams, a difference of 225 grams. The significant differences observed are likely to be attributed to other important factors such as individual, cultural, societal and environmental factors which were not available for analysis and were unlikely to reflect differences in genetic make-up. Individual factors include mother's general health and nutrition (Mishra, Thapa, Retherford & Dai, 2005; Sacks, 2004), education level (Halileh, Abu-Rmeileh, Watt, Spencer & Gordon, 2008) and whether the mother received prenatal care (Celik & Younis, 2007; Lu, Kotelchuck, Hogan, Johnson & Reyes, 2010) during her pregnancy. These are all well-known factors that contribute to the birth outcomes of an infant. In the same way, environmental factors such as pollution contribute to adverse birth outcomes. Mishra et al's (2005) study on Zimbabwe mothers, found that mothers who cooked with high-pollution fuels namely wood, dung or straw had lighter babies at birth (144 grams lighter) than

mothers who cooked with low-pollution fuels (natural gas, electricity or liquefied petroleum gas; ( $p = .022$ ). This offers a potentially valid explanation for the marked difference observed between the two Samoan samples mean birth weights. For the vast majority of households in Samoa, it is still common practice for women to conduct all cooking activities in an outside kitchen over an open fire. However, as the aforementioned individual and environmental factors among others were not available for analysis, inferences as to the impact or influence of these factors on the results cannot be made. Therefore, further in-depth research is needed to gain a true picture of the associated factors influencing the birth outcomes of Samoan infants. Another interesting finding was the significant effect the predictor variables had on the mean birth weights of the two sample populations. Significant differences existed between country ( $p < 0.001$ ), maternal age categories ( $p < 0.001$ ), parity ( $p < 0.001$ ) and infant sex ( $p = 0.02$ ), a consistent finding with those reported in international studies (Halileh, Abu-Rmeileh, Watt, Spencer & Gordon, 2008; Ngui, Cortright & Blair, 2008). However, what is particularly noteworthy in this analysis is the non-significant finding obtained for mothers' smoking status prior to conceiving for both birth samples. Samoan mothers both in Samoa and Aotearoa New Zealand who had a history of smoking prior to conceiving had no significant effect on the birth outcome of their child. In other words, smoking behaviour prior to pregnancy did not significantly impact on the birth weight of their child. As there is a high correlation between pre-pregnancy smoking status and pregnancy smoking status (Colman & Joyce, 2003), this finding together with the evidence that smoking status is strongly associated with average birth weight (Pollack, Lantz & Frohna, 2000; Veloso da Veiga & Wilder, 2008; Visscher, Feder & Burns et al., 2003), makes this null finding counter-intuitive. One explanation for this finding may be due to maternal recall bias or misclassification (see Ford, Tappin, Schluter & Wild, 1997 for details). Moreover, in the case of the TTM birth sample, the smoking status of mothers was obtained on their first ever visit to the hospital, and is not updated when mothers are admitted for the delivery of their babies. The information on these mothers' hospital records then could date from as early as their first childhood visit, or taken from their first birth delivered in the hospital.



Also, not all Samoan births take place within the main TTM hospital or any hospital for that matter. In fact, many Samoan births take place within expectant mothers' homes and this may introduce differential non-sampling biases. Throughout Samoa, and within each village resides a traditional birthing attendant (TBA). TBAs use traditional methods of maternity care such as *fōfō* (massage) to assist birth delivery, and they often remain with and care for the mothers after child birth. The only time any of these mothers would present themselves to the main hospital is if they were referred by the TBA due to complications. This highlights the importance of collecting reliable information from participants, as well as the need for reliable tools when collecting primary data.

On first glance, another surprising finding was Samoan PIF infants were almost three times more likely than Samoan TTM infants to be either preterm or low birth weight even after adjusting for all available explanatory variables. Anecdotal evidence suggest that Cook Island expectant mothers residing in the Cook Island archipelago and experiencing complications during their pregnancy are flown to Aotearoa New Zealand to receive specialist care and close monitoring by Aotearoa New Zealand hospital medical staff (P. Schluter, personal communication, December 14, 2010). However this may not be the case in Samoa. Unlike the Cook Islands who are afforded the same citizenship rights as Aotearoa New Zealand nationals, Samoans within the independent state are not afforded these rights. Therefore this explanation although appropriate with annexed states of Aotearoa New Zealand such as Niue, Tokelau, Tuvalu and Cook Islands may not be an appropriate explanation for Samoan citizens. The scarce literature that exists on Samoan health statistics suggest referrals by the Samoan TTM hospital are made for treatment outside; however details of the type and severity of illness, and the location of the referral is not given (Ministry of Health – Samoa, 2008). However what could be offered as an explanation for the prevalence of preterm births among Samoan PIF mothers is that these mothers may in fact be Samoan Aotearoa New Zealand nationals or citizens returning to birth their child. Mothers who are foreign born are more likely than Samoan born mothers to return to their home of origin to deliver their babies (see methods sections, p. 55). The same can be said for Samoan mothers who are Aotearoa New Zealand nationals or citizens and financially

able. They are more likely than their Samoan born counterparts to return to Aotearoa New Zealand to give birth to their children. Moreover, the higher prevalence of preterm and low birth weight infants in the Samoan PIF infants may be due to differences in clinical practice. Aotearoa New Zealand physicians may be more likely to induce early labour, once high risk pregnancies are identified. Furthermore, Aotearoa New Zealand may conduct more higher risk deliveries than their island nation counterpart. However, future research will benefit from the recording of these variables, to assess whether this is actually the case.

What is more interesting, of all the potential predictor variables investigated, marital status alone was the only significant predictor of either low birth weight or preterm births for the two birth samples. PIF mothers in de facto relationships had the highest odds of delivering either a preterm or low birth weight infant compared to TTM mothers. These results are motivated by the excess numbers of preterm infants recorded for the PIF birth sample. The marked differences in preterm and low birth weight, observed between the two sample populations, may be explained by different clinical practices employed by each country as outlined above. Non sampling bias could also account for the small proportion of preterm and low birth weight infants recorded for the TTM sample, as again, only expectant mothers that attend and birth their child at the National Samoan Hospital are recorded in the hospital records. In the case of the PIF mothers, those in de facto relationships have higher odds of having preterm and/or low birth weight infants, could be attributed to the mixed ethnicity of the infant. The PIF infants are more likely than TTM infants to be of mixed heritage. The proportion of Samoans in Aotearoa New Zealand identifying solely as Samoan numbered 66%, while 64% of Samoans under the age of 15 years identified with two other ethnicities, the most common grouping of ethnicities being Samoan/Pacific/European. This is a possible reason to explain the pronounced proportion of preterm and low birth weight infants born to Samoan PIF de facto mothers; however this remains to be understood and therefore warrants further investigation.

Also noteworthy is that TTM single mothers have significantly higher odds of having a preterm and low birth weight infant compared to TTM mothers who are married and/or in de facto relationships. An explanation for this occurrence comes from

numerous epidemiological studies that link infants born to single mothers with being at higher risk of preterm and low birth weight (Berzosa et al., 1993 and Bortman, 1998 cited in Valero de Bernabé et al., 2004). This finding reinforces already established notions that married women experience better maternal health and infant health outcomes as their marital status acts as a protective barrier from adverse birth outcomes.

From a Samoan cultural point of view, the stigma of being an unmarried woman with child in Samoa, a proud 'God' fearing community, is prevalent and would increase the likelihood of disadvantage to that woman and child. The traditional ideals of marriage before premarital sex are strongly embedded within Samoa society. Sexual conduct outside the sacred confinements of a recognised marriage is shunned. Samoan women have distinct roles within their village or *nu'u* setting which are often determined by her age, marital status, political and social status. Moreover, whether she was born in the village or married someone of the village, (that is *nofotane*, living at her husband's village) also has great implications on her social standing. It is understood that Samoan women who marry and remain within her birth village with her family have better status than women, who marry and reside within their spouse's village (Government of Samoa & Unicef, 2006). Single women then, who conceive outside these religious and cultural confines would still be expected to serve within the village community as if they were still single and without a child. The assumption is that single mothers in Samoa are more likely than her married and/or de facto equivalents, have to work right up until the time she is due to deliver. This suggests that single pregnant women in Samoa have to be self reliant and proactive in creating economic opportunities for themselves, their child(ren) and immediate family members (Government of Samoa & Unicef, 2006). Again these findings support the theory that married women, who have a supportive spouse, are more inclined to experience favourable birth outcomes.

## **6.2 The need for more Pacific research**

What is known and what continues to inform maternal and infant health research comes from international studies, which compare minority groups (within their respective countries) with the dominant white Caucasian population. It is from this

research that we gain knowledge about birth weight, specifically low birth weight and its contribution to adverse health outcomes. However, little research has been performed on ethnic specific populations, particularly within and between these minority populations – therefore it is timely and appropriate that research extends its scope to include the investigation of Pacific ethnic groups in Aotearoa New Zealand.

Often the health status of Pacific people in Aotearoa New Zealand have been reported as one homogeneous group (Blakely et al., 2009); however in recent times, health researchers have identified the need to recognize the diversity of Pacific peoples' ethos, their cultural practices and traditions and thus varied health needs. The PIF Study, based in the Centre for Pacific Health and Development Research, Auckland University of Technology (AUT) has, since its inception, long recognized the need for more Pacific ethnic specific health research and is committed to developing a workforce of young Pacific researchers to address this need.

The recognition of the dearth of literature on Pacific ethnic specific research, particularly between populations that are Island born and their western born equivalents has prompted the current study. This particular study focused on ethnic Samoans in both Samoa and Aotearoa New Zealand. Ethnic Samoans are the largest represented Pacific peoples in Aotearoa New Zealand, and also the largest Pacific population to have native born (Samoans) reside in Aotearoa New Zealand. This Samoan ethnic group would account for proportionately more Pacific infant mortality numbers and fertility numbers reported in Aotearoa New Zealand than any other Pacific Island ethnic group

Until recently, Samoan babies born in Samoa have experienced low rates of infant mortality compared to other developing countries (Annandale, 2003), and like their Pacific counterparts in Aotearoa New Zealand, are also less likely to be of low birth weight (Ministry of Health & Ministry of Pacific Island Affairs, 2004). The reduction of child mortality is a priority for the Samoan Government and health officials who, in the past two decades have been successful in markedly decreasing Samoa's infant mortality rate (Ministry of Finance, 2008), allowing Samoa to claim victory at having already achieving Goal 4 of the Millennium Development Goals set out by the UNFPA;

to *'reduce child mortality by two thirds for children under the age of five'* (United Nations, 2008; Ministry of Health, 2008). However the recent increase in infant mortality rates in Samoa is a growing concern (Annandale, 2003).

This increase in infant mortality experienced by both the Pacific population in Aotearoa New Zealand and neighbouring Samoan Islands provokes concern and requires in-depth investigation to gain insight into the factors that contribute to the increased infant mortality rates. Sundborn (2007) postulated the need for a new definition of low birth weight (<3000g rather than <2500g) for Pacific populations. If low birth weight thresholds are incorrect for Pacific infants, the re-establishment of a more accurate measure may help identify at risk Pacific infants and ensure that they receive appropriate care. For instance, if an infant is identified as being at risk of low birth weight, they are induced and then placed in the neonatal intensive care unit where they receive twenty-four hour monitoring and medical care. Moreover, the duration of their stay in the intensive care unit is dependent upon the severity of their condition. Receiving timely, appropriate care, may then address disparities in infant mortality in Aotearoa New Zealand. Similarly the re-establishment of a more accurate measure may help identify at risk Samoan infants.

### **6.3 Data collection from Samoa**

It was the collection of data from Samoa that would pose the most challenges to this project, as explained in detail in chapter four under procedures. However, the process would define future research approaches when engaging with the people and communities in Samoa. It became apparent that the cultural appropriateness of procedures and protocols surrounding the conduct of research in Samoa is paramount. It is important then to consider the culture and social norms that govern the host community in which research is to be conducted. In the case of this study, the host country of Samoa observes the *vā*, social relational protocols when interacting with each other. It was through the act of observing the *vā* that triggered a series of *vā* interrelations between key cultural intermediaries who would in turn use their professional *vā* networks to gain the essential birth weight data for the present study. It must be stated and clearly understood that *vā* interrelations do not supersede

bureaucratic process and neither does the author advocate the use of cultural intermediaries to override these necessary formalities. Instead, it is strongly advised that cultural intermediaries be included when conducting culturally apt research in Samoa.

Moreover, it became apparent that the whole process of adhering to the host country's protocols complements Smith's (2006) argument for decolonising the processes of the more accepted approach of western methodologies. The Samoan government and academics have united to protect Samoa's intellectual property. To gain their consent, for the present research, the AUT researchers had to comply and adhere to the formal research protocols. There are lessons then to be learnt and protocols to adhere to when researching abroad. The methods employed within offer insight into conducting culturally appropriate research within Samoa. This in turn offers insight into engaging with Pacific communities outside Aotearoa New Zealand.

Central to the present study is the consideration of a Pacific specific low birth weight threshold of <3000 grams. However, there is much debate around the standard low birth weight threshold and its universal application as a reliable predictor of ill infant health. What follows then is a discussion on low birth weight using the seminal works of Wilcox and Russell (1990) and Wilcox (2001). At the same time, reflective comments have been inserted to help contextualise the relevance of Wilcox's works to the current study.

#### **6.4 Wilcox and low birth weight alternatives**

These deliberations on low birth weight are framed by the seminal essays by Wilcox and Russell (1990) and Wilcox (2001). The first argues for an ethnic specific population low birth weight threshold and paradoxically, the second dismisses the low birth weight standard alone as a significant predictor of at risk populations. Using the Gaussian bell shaped curve to describe population birth weight distributions, Wilcox (2001) likens the area directly under and within the curve as the predominant distribution. The remaining areas at the tail and outside the curve represent the residual area. It is the birth weights within the residual distribution that Wilcox (2001) describes as being all preterm, small and higher risk of infant mortality, a more apt

measure of a population's risk than the low birth weight standard. However Wilcox and Russell (1990) and Wilcox (2001) inform the current study. Firstly, this study argues for an ethnic specific low birth weight threshold and recognises the difficulties of low birth weight as a sole indicator of at risk populations. Secondly, birth weight is a common variable to both population samples, and although Wilcox (2001) denies the usefulness of the low birth weight standard, he inadvertently advocates its value in offering alternatives to low birth weight. The first low birth weight alternative Wilcox (2001) proposes is if birth weights are the only available variable then consider first the percentage of births within the residual distribution as opposed to low birth weight. As previously mentioned, residual births are all preterm, at higher risk of poor perinatal health, and thus is a more reliable predictor than low birth weight of a population's risk. This seems at odds with the majority of epidemiological studies which deduce the proportion of preterm births (and low birth weight) in their preliminary analyses of birth weights. Analogous is the process used in the current study, done so to determine the proportion of preterm and low birth weight infants within the two Samoan birth samples. Furthermore, by identifying the proportion of preterm (and low birth weight) births meant that the exclusion of preterm births from subsequent multivariable analyses would allow for like comparisons between the two Samoan sample populations. This directly aligns with Wilcox's (2001) second alternative to low birth weight. Wilcox (2001) recommends that the direct examination of preterm births within a population should be considered whenever possible. Wilcox (2001) purports that actual preterm data coupled with good quality gestational information provides a represented percentage of preterm births within a population of interest. The calculation of the percentage of preterm births, allows the subsequent analysis to be restricted to term births only, in which case gestational information is negligible. The analysis of term births only, within a given population and between populations, allows the comparison of foetal growth across different groups. The author opines that Wilcox's (2001) recommendations implicitly vouch for the use of ethnic specific low birth weight measures.

Despite considerable opposition to the use of the low birth weight standard as a reliable predictor of perinatal risk, low birth weight today remains the standard

measure used among epidemiologists and health researchers worldwide. This study then sees the merits of a low birth weight threshold based on ethnic specific birth weight distributions. It argues for the use of the 10<sup>th</sup> percentile range as opposed to the absolute measure of low birth weight and therefore endorses the value of a low birth weight measure that is based on population-specific standards as an indicator of at risk populations.

## **6.5 Strengths and weaknesses**

### **6.5.1 Strengths**

The defining feature of this research is the Samoan birth dataset and accompanying maternal and infant information from the National Hospital in Samoa – Tupua Tamasese Meaole Hospital. This is of particular significance because the area of Pacific maternal and infant health is often highlighted as a key area of concern for public health officials and researchers abroad, as it is generally accepted that improvements in maternal and infant health outcomes has overall health benefits for the country. However there is very little empirical data around this topic that pertains to Pacific communities. This then makes the current study a significant contribution to the study of Pacific maternal and infant health outcomes, particularly of one ethnic Pacific group between two distinct locations. Although it can be argued that international European communities have long researched the effects of maternal health on perinatal risk, it must be pointed out that none of these studies have compared a specific Pacific population within a western society with their Island born equivalents. This ethnic specificity, in two different geographic locations, again makes the current study a valid contribution to Pacific infant health research. However, questions may arise about the generalisability of the findings to the wider Pacific community in Aotearoa New Zealand, and whether the Pacific ethnic group of Aotearoa New Zealand Samoans used in the study is a valid representative of all Pacific people in Aotearoa New Zealand, given that the Samoan population in Aotearoa New Zealand is the largest Pacific population, accounting for 49% of the Pacific population. Similarly, the PIF sample population of Samoans is also largely representative of the national Samoan population. The findings regarding the Samoan population impacts on the overall



Pacific profile. Therefore inferences and generalisations made to the wider Pacific population from this study may be apt. However, further ethnic specific studies of the various Pacific communities in Aotearoa New Zealand and comparisons with Island populations are required to provide more definitive comparisons.

Another significant strength of this particular study was the use and practice of the cultural concept of *vā*. Essentially, it was the *vā* that enabled the present research to progress. Through observing the *vā*, the employment of cultural intermediaries that were prepared to activate their own social and professional *vā* networks created a smooth passage in Samoa. More importantly, it was the kinship *vā* that resulted in the actual data collection proper. However, an added strength of the *vā* playing a crucial role in the present study is the fact that the student researcher herself is Samoan. This is a strength of the study, particularly as the thesis topic was focused on Samoan mothers and their infants. Although no actual primary data collection, interviews or one on one contact with participants took place, the student researcher was able to speak Samoan, making her engagement with the Samoan people in Samoa much easier. This culturally appropriate practice of having an ethnically matched student researcher coupled with the student's *vā* networks contributed to the success of gaining crucial birth weight data for the present study.

Another key feature of this research is the use of sophisticated analytic techniques of generalized estimating equation (GEE) models to examine the two Samoan birth datasets. Furthermore, the reasonably large sample sizes of the two birth samples, 1,052 and 647 for TTM and PIF birth population samples respectively provided a representative sample of both birth sample populations allowing for inferences from the study's findings to be made to the wider Samoan populations within each respective country.

### **6.5.2 Weaknesses**

Ironically, the strength of this thesis (i.e., the Samoan TTM dataset) was also its greatest weakness, as the variables that were collected from Samoa for the TTM birth dataset were limited. This was due to the data collection criteria employed in Samoa,

in that the information they collected did not encompass as many variables as the Auckland New Zealand PIF study. This meant that the Samoan TTM dataset became the baseline criteria for like comparisons between the two sample populations. Furthermore, little is known of instruments used in Samoa to weigh babies and whether these subsequent birth weight measurements were accurate. In the same way, the documentation of variables such as the smoking status of mothers and gestation weeks by LMP could also be queried. This gives rise to potential non-sampling errors and poses questions around the potential biases of the findings from the study. What is more, it questions whether the TTM sample is representative of all Samoan births in Samoa and whether inferences from the study's findings can be made of the wider Samoan population. The same can also be said of the PIF study as non sampling errors also threaten the generalisability of the findings of the PIF sample to the wider Samoan population in Aotearoa New Zealand. Similarly, both samples are taken from hospital settings within each respective country, thus biasing the findings to only reflect Samoan mothers, who for various reasons (such as proximity to the hospital and complications for referral to that hospital) opt to birth within these hospitals. This, in itself, would then place doubt on the generalisability of the findings to the wider Pacific population. However, both TTM and PIF samples are large and representative of the Samoan populations they serve, and Samoans in Aotearoa New Zealand largely determine the overall demographic profile of Pacific people. The findings obtained from conducting this study then pose a strong argument for the development of Pacific specific measures of low birth weight.

Finally, one other noteworthy limitation of this study is the limited number of birth outcomes collected from the two birth sample populations, specifically, mortality and morbidity information during the perinatal and post-natal periods. The unavailability of this data limits the scope of this study as inferences cannot be made about whether the proposed low birth weight threshold of <3000 grams is appropriate for identifying at risk Pacific infants, and predicting infant survival during the first year of life. Ideally, the study would have benefited from having these outcome data to examine whether the proposed low birth weight threshold could indeed make a difference in reducing infant mortality and morbidity experienced by the two samples, through the timely

identification of at risk infants, and appropriate interventions being conducted. Not until this data is collected can such inferences be made.

The data for Samoan babies between 2500 grams and 3000 grams have not been collected for Samoan babies simply because they are outside the conventional low birth weight threshold. These babies also look relatively healthy. However, the high rates of neonatal and post-neonatal mortality among Pacific infants require a more radical approach to screening for at risk infants (Ministry of Health and Ministry of Pacific Island Affairs, 2004). Raising the low birth weight threshold to <3000 grams would capture more of the neonatal and post-neonatal at risk populations. It is outside the scope of this study, but the researcher surmises that some consideration as to the interventions of neonatal intensive care units will be necessary: arrhythmic heart beats, respiratory complications and other adverse birth outcomes may very well be prevalent in this population. By raising the low birth weight threshold to <3000 grams will ensure this population receives monitoring and 24 hour intensive care.

## **Chapter 7 – Conclusions and Recommendations**

The following chapter presents the conclusions drawn from the results and discussion. In addition, recommendations based on the findings of this study are also presented below.

### **7.1 Conclusions**

Despite the limitations of the present study, the overall findings advocate the use of population specific low birth weight thresholds, based on individual populations' 10<sup>th</sup> percentile birth weights. Furthermore the current study supports Sundborn's (2007) proposed low birth weight threshold of <3000 grams for a Samoan population. Based on a representative sample of the Samoan infants born in Samoa and New Zealand, the findings may then be reflective of the birth weight patterns of the wider Pacific population within Aotearoa New Zealand. This is supported by the fact that Samoans residing within Aotearoa New Zealand significantly shape the demographic profile of Pacific people. However the same cannot be said of the Samoans in Samoa being a representative sample of the wider Pacific Island states. Findings from this study can inform public health policy and health promotion programmes targeting and improving maternal and infant health outcomes for Pacific people in Aotearoa New Zealand.

## **7.2 Recommendations**

This study advocates the use of ethnic specific low birth weight thresholds whenever possible. Low birth weight thresholds for the Samoan population should be raised to 3000 grams. Based on the large sample size of the Samoan PIF cohort and the strong influence of the Samoan population on the composition of Aotearoa New Zealand Pacific population, the findings from this particular study contributes to a strong case for the consideration of a Pacific specific low birth weight threshold.

In addition, this study advocates the use of Wilcox (2001) alternatives to LBW measures when the major variables are limited to birth weights and gestational age. Assuming gestational age is accurately recorded then the direct analysis of preterm births within a given population is a more desirable and reliable measure than birth weight itself.

Furthermore the findings suggest the use of more comprehensive research methods such as interviews and surveys be employed for future research projects in Samoa. This would enhance the quality of the results by providing rare insights and experiences into factors that contribute to Samoan mothers and their infants' birth outcomes. This study then advocates the need for more ethnic Pacific research on mothers and their infants within and between the various Pacific ethnic groups. Only then can the true disparities that lie between Pacific people and the dominant European Aotearoa New Zealand population be known.

A unique recommendation as a consequence of this study, the author further advocates the adoption of Island based procedures and protocols when engaging in research in the Pacific. At present there are few formalised research procedures set up by Island nations that are recognised by foreign researchers. AUT University can play a major role in setting up procedures and protocols.

## References

- Anderson, N.A., Brown, E.W., & Lyon, R.A. (1943). Causes of prematurity III: Influence of race and sex on duration of gestation and weight at birth. *American Journal of Diseases of Children*, 65(4), 523-534.
- Annandale, V. (2003). Widening Health Choices: A general view of health issues in the year 2000. In P.Fairbairn-Dunlop (Eds.), *Samoan Women: Widening choices* (pp. 28-37). Suva, Fiji: Institute of Pacific Studies, University of the South Pacific: Samoa Association of Women Graduates.
- Appleyard, R.T., & Stahl, C.W. (1995). *South Pacific migration: New Zealand experience and implications for Australia*. Australia: CPN Publications.
- Barker, D.J.P. (2003). Editorial: The development origins of adult disease. *The European Journal of Epidemiology*, 18, 733-736.
- Barker, D.J.P. (2004). The developmental origins of well-being. *The Philosophical Transactions: Biological Sciences*, 359, 1359-1366.
- Bedford, R., & Didham, R. (2001). Who are the 'Pacific Peoples'? Ethnic identification and the New Zealand Census. In C. Macpherson., Spoonley, P and Anae, M. (Eds.), *Tangata o te moana nui* (pp. 21-43). Palmerston North, New Zealand: Dunmore Press Ltd.
- Beaglehole, A. (2009). *Immigration regulation - 1986-2003: selection on personal merit. Te Ara – the Encyclopedia of New Zealand*. Retrieved from <http://www.teara.govt.nz/en/immigration-regulation/5>
- Blondel, B., Kogan, M.D., Alexander, G.R., Dattani, N., Kramer, M.S., Macfarlane, A., Wen, S.W. (2002). The impact of the increasing number of multiple births on the rates of preterm birth and low birthweight: An international study. *American Journal of Public Health*, 92(8), 1323-1330.
- Boardman, J.D., Powers, D.A., Padilla, Y.C. & Hummer, R.A. (2002). Low birth weight, social factors, and developmental outcomes among children in the United States. *Demography*, 39, 353-386.
- Bross, D.S. & Shapiro, S. (1982). Direct and indirect associations of five factors with infant mortality. *American Journal of Epidemiology*, 115, 78-91.
- Brown, E.W., Lyon, R.A., & Anderson, N.A. (1945). Causes of prematurity IV. Influence of maternal illness on the incidence of prematurity: Employment of a new criterion of prematurity for the Negro race. *American Journal of Diseases of Children*, 70, 314-317.
- Butler, S., Tukuitonga, C., Paterson, J., & Williams, M. (2002). Infant feeding and feeding problems experienced by mothers of a birth cohort of Pacific infants in New Zealand. *Pacific Health Dialog: Journal of Community Health and Clinical Medicine for the Pacific*, 9(1), 34-39.

- Celik, Y., & Younis, M.Z. (2007). Effects of antenatal care services on birthweight: Importance of model specification and empirical procedure used in estimating the marginal productivity of health inputs. *Journal of Medical Systems*, 31(3), 197-204. doi: 10.1007/s10916-007-9055-2
- Chomitz, V.R., Cheung, L.W.Y. & Leiberman, E. (1995). The role of lifestyle in preventing low birth weight. *The Future of Children*, 5, 121-138.
- Cook, L., Didham, R. & Khawaja, M. (2001). The shape of the future: On the demography of Pacific peoples. In C. Macpherson., Spoonley, P and Anae, M. (Eds.), *Tangata o te moana nui* (pp. 11-15). Palmerston North, New Zealand: Dunmore Press Ltd.
- Costa, D.L. (1998). Unequal at birth: A long-term comparison of income and birth weight. *The Journal of Economic History*, 58, 987-1009.
- Cramer, J.C. (1987). Social factors and infant mortality: Identifying high-risk groups and proximate causes. *Demography*, 24, 299-322.
- Davies, D.P., Senior, N., Cole, G., Blass, D. & Simpson, K. (1982). Size at birth of Asian and white Caucasian babies born in Leicester: implications for obstetric and paediatric practices. *Early Human Development*, 6, 257-263.
- Deka, R., Mc Gavey, S.T., Ferrell, R.E., Kamboh, M.I., Yu, L.M., Aston, C.E., ...Chakraborty, R. (1994). Genetic characterization of American and Western Samoans. *Human Biology*, 66(5), 805-822.
- Durham, E., Jenss, R.M., & Christie, A.U. (1939). A consideration of race and sex in relation to the growth and development of infants. *The Journal of Pediatrics*, 14(2), 156-160.
- Duval County Health Department. (2006). Infant mortality: National challenges, progress and disparities. *Center for Health Statistics Report: Infant Mortality*, 5, 1-11.
- Eberstein, I.W., Nam, C.B. & Hummer, R.A. (1990). Infant mortality by cause: Main and interaction effects. *Demography*, 27, 413-430.
- Eberstein, I.W. & Parker, J.R. (1984). Racial differences in infant mortality by cause of death: The impact of birth weight and maternal age. *Demography*, 21, 309-321.
- Encyclopedia of Public Health. (n.d.). *Encyclopedia of Public Health*. Retrieved from <http://www.enotes.com/public-health-encyclopedia/cross-sectional-study/print>
- Ford, R.P., Tappin, D.M., Schluter, P.J., & Wild, C.J. (1997). Smoking during pregnancy: how reliable are maternal self reports in New Zealand? *Journal of Epidemiology and Community Health*, 51, 246-251. doi:10.1136/jech.51.3.246
- Frisbie, W.P. (2005). Infant mortality. In D.L. Poston & M. Micklin (Eds.), *Handbook of population* (pp. 251-282). Boston, M.A.: Kluwer Academic Publisher.

- Frisbie, W.P., Forbes, D. & Pullum, S.G. (1996). Compromised birth outcomes and infant mortality among racial and ethnic groups. *Demography*, 33, 469-481.
- Gao, W., Paterson, J., Carter, S. & Percival, T. (2006). Risk factors for the preterm and small for gestational age babies: A cohort from the Pacific islands Families study. *Journal of Paediatrics and Child Health*, 42, 785-792.
- Government of Samoa and UNICEF. (2006). *Samoa: A situation analysis of children, women and youth*. Suva, Fiji: UNICEF Pacific Office.
- Gray, A. (2001). *The definition and measurement of ethnicity: A Pacific perspective: A discussion paper prepared for Statistics New Zealand*. Wellington, New Zealand: Author.
- Green, D. (2009). *Citizenship. Te Ara – the Encyclopedia of New Zealand*. Retrieved from <http://www.teara.govt.nz/en/citizenship/3/5>
- Halileh, S., Abu-Rmeileh, N., Watt, G., Spencer, N., & Gordon, N. (2008). Determinants of birthweight: Gender based analysis. *Maternal and Child Health Journal*, 12(5), 606-612. doi: 10.1007/s10995-007-0226-z
- Healthpoint. (2010). *Public Hospital: Middlemore Hospital*. Retrieved from <http://www.healthpoint.co.nz>
- Hummer, R.A., Biegler, M., De Turk, P.B., Forbes, D., Frisbie, W.P., Hong, Y. & Pullum, S.G. (1999). Race/ethnicity, nativity, and infant mortality in the United States. *Social Forces*, 77, 1083-1118.
- Hummer, R.A., Eberstein, I.W. & Nam, C.B. (1992). Infant mortality differentials among Hispanic groups in Florida. *Social Forces*, 70, 1055-1075.
- Kallan, J.E. (1993). Race, intervening variables, and two components of low birth weight. *Demography*, 30, 489-506.
- Krishnan, V., Schoeffel, P. & Warren, J. (1994). *The challenge of change: Pacific island communities in New Zealand, 1986 – 1993*. Wellington, New Zealand: New Zealand Institute for Social Research & Development Ltd.
- Li, C.I., Daling, J.R. & Emanuel, I. (2003). Birthweight and risk of overall and cause-specific childhood mortality. *Paediatric and Perinatal Epidemiology*, 17, 164-170.
- Lilomaiaava-Doktor, S. (2004). *Fa'aSamoa and population movement from inside out: The case of Salelologa, Savaii*. (Doctoral dissertation, University of Hawaii). Retrieved from <http://proquest.umi.com/pqdlink?did=775166111&Fmt=7&clientId=7961&RQT=309&VName=PQD>
- MacDorman, M.F., Declercq, E., Menacker, F. & Malloy, M.H. (2006). Infant and neonatal mortality for primary cesarean and vaginal births to women with “no indicated risk,” United States, 1998-2001 birth cohorts. *Birth*, 33, 175-182.



- Macpherson, C. (2004). Chapter 7: From Pacific Islanders to Pacific people and beyond. In P. Spoonley, C. Macpherson & D. Pearson (Eds.), *Tangata Tangata: The changing ethnic contours of New Zealand* (pp. 135-156). VIC, Australia: Thomson Dunmore Press.
- Macpherson, C., & Macpherson, L. (2009). *The warm winds of change: Globalisation in contemporary Sāmoa*. Auckland, New Zealand: Auckland University Press.
- Macpherson, C., Spoonley, P. & Anae, M. (2001). Pacific people in NZ: an introduction. In C. Macpherson., P. Spoonley & M. Anae (Eds.), *Tangata o te moana nui* (pp. 11-15). Palmerston North, New Zealand: Dunmore Press Ltd.
- Mathews, T.J., Menacker, F., & MacDorman, M.F. (2004). Infant mortality statistics from the 2002 period linked birth/infant death data set. *National Vital Statistic Reports*, 53, 1-32.
- McCowan, L. & Stewart, A.W. (2004). Term birthweight centiles for babies from New Zealand's main ethnic groups. *Australian and New Zealand Journal of Obstetrics and Gynaecology*, 44, 432-435.
- McCowan, L., Stewart, A.W., Francis, A. & Gardosi, J. (2004). A customised birthweight centile calculator developed for a New Zealand population. *Australian and New Zealand Journal of Obstetrics and Gynaecology*, 44, 428-431.
- Mara, D.L. (2006). *Theories and narratives: Pacific women in tertiary education and the social construction of ethnic identities in Aotearoa New Zealand*. (Unpublished doctoral thesis). Victoria University of Wellington, Wellington, New Zealand.
- Ministry of Finance. Samoa. (2008). *Strategy for the development of Samoa 2008-2012: Ensuring sustainable economic and social progress*. Retrieved from [http://www.mof.gov.ws/uploads/sds\\_2008\\_2012\\_english.pdf](http://www.mof.gov.ws/uploads/sds_2008_2012_english.pdf)
- Ministry of Health. (2001a). *Health facts July 2001: The health sector at a glance*. Retrieved from <http://www.moh.govt.nz/moh.nsf/pagesmh/818?Open>
- Ministry of Health. (2001b). *Life expectancy and small area deprivation in New Zealand*. Wellington, New Zealand: Author.
- Ministry of Health. (2001c). *Priorities for Māori and Pacific health: Evidence from epidemiology* (Public Health Intelligence Occasional Bulletin No 3). Wellington, New Zealand: Author.
- Ministry of Health. (2003). *New Zealand Health and Disability Sector Overview*. Wellington, New Zealand: Author.
- Ministry of Health. (2005). *The health of Pacific peoples*. Wellington, New Zealand: Author.
- Ministry of Health (2010). *Tatau kahukura: Māori health chart book 2010*. Wellington, New Zealand: Author.

- Ministry of Health and Ministry of Pacific Island Affairs. (2004). *Tupu ola moui: Pacific health chart book 2004*. Wellington, New Zealand: Author.
- Ministry of Health. Samoa. (2008). *Health sector plan 2008: English version*. Retrieved from [http://www.health.gov.ws/UserFiles/File/Health\\_Sector\\_Plan\\_english.pdf](http://www.health.gov.ws/UserFiles/File/Health_Sector_Plan_english.pdf)
- Ministry of Health & Statistics New Zealand. (2009). *Longer life, better health? Trends in health expectancy in New Zealand, 1996–2006*. Wellington, New Zealand: Author.
- Mongelli, M., Figueras, F., Francis, A., & Gardosi, J. (2007). A customised birthweight centile calculator developed for an Australian population. *Australian and New Zealand Journal of Obstetrics and Gynaecology*, 47, 128-131.
- New Zealand History Online. (n.d.). *1982 Privy Council rules on Samoan citizenship*. Retrieved from <http://www.nzhistory.net.nz/timeline/19/07>
- Ngui, E., Cortright, A., & Blair, K. (2009). An investigation of paternity status and other factors associated with racial and ethnic disparities in birth outcomes in Milwaukee, Wisconsin. *Maternal and Child Health Journal*, 13(4), 467-478. doi: 10.1007/s10995-008-0383-8
- Osmond, C. & Barker, D.J.P. (2000). Fetal, infant, and childhood growth are predictors of coronary heart disease, diabetes, and hypertension in adult men and women. *Environmental Health Perspectives*, 108, 545-553.
- Pampel, F.C. & Pillai, V.K. (1986). Patterns and determinants of infant mortality in developed nations, 1950-1975. *Demography*, 23, 525-553.
- Puaina, S., Aga, D.F., Pouesi, D., & Hubbell, F.A. (2008). Impact of traditional Samoan lifestyle (*fa'aSamoa*) on cancer screening practices. *Cancer Detection and Prevention*, 32S, S24-S28.
- Paterson, J., Tukuitonga, C., Abbott, M., Feehan, M., Silva, P., Percival, T., ... Giles, L. (2002). *Pacific Islands Families: The first two years of life study. Technical report 1*. Auckland, New Zealand: Auckland University of Technology.
- Paterson, J., Tukuitonga, C., Abbott, M., Feehan, M., Silva, P., Percival, T., ... Williams, M. (2004). *Pacific Islands Families: The first two years of life (PIF:FTY) study. Technical report 2*. Auckland, New Zealand: Auckland University of Technology.
- Paterson, J., Tukuitonga, C., Abbott, M., Feehan, M., Silva, P., Percival, T., ... Schluter, P. (2006). Pacific Islands Families: First two years of life study-design and methodology. *New Zealand Medical Journal*, 119(1228), 63-80. Retrieved from <https://www.nzma.org.nz/journal/119-1228/1814/>
- Paterson, J., Percival, T., Schluter, P., Sundborn, G., Abbott, M., Carter, S., ... Gao, W. (2008). Cohort profile: The Pacific Islands Families (PIF) Study. *International Journal of Epidemiology*, 37(2), 273-279. doi: 10.1093/ije/dym171

- Roberts, J.M., Pearson, G., Cutler, J. & Lindheimer, M. (2003). Summary of the NHLBI working group on research on hypertension during pregnancy. *Hypertension*, 41, 437-445.
- Rooth, G. (1980). Low birthweight revised. *The Lancet*, 1, 639-641.
- Saisoa'a, M. (2008). Chapter 21: Nga hekenga hou: Pacific peoples in Aotearoa/New Zealand. In T.M. Ka'ai, J.C. Moorfield, M.P. Reily, & S. Mosley (Eds.), *Ki Te Whaiao: An introduction to Māori culture and society*. (pp. 227-237). North Shore, New Zealand: Pearson Education.
- Samoa Bureau of Statistics. (2008). *Samoa: Population and Housing Census Report 2006*. Retrieved from [http://www.sbs.gov.ws/Portals/138/PDF/census%20survey/2006\\_census.pdf](http://www.sbs.gov.ws/Portals/138/PDF/census%20survey/2006_census.pdf)
- Shah, P. & Ohlsson, A. (2002). *Literature Review of Low Birth Weight, Including Small for Gestational Age and Preterm Birth*. Submitted to Toronto Public Health Ohlsson. Toronto, Ontario, Canada: Evidence Based Neonatal Care and Outcomes Research Unit. Department of Pediatrics. Mount Sinai Hospital. Retrieved from [http://www.toronto.ca/health/low\\_birth\\_weight/pdf/lbw\\_lit\\_review.pdf](http://www.toronto.ca/health/low_birth_weight/pdf/lbw_lit_review.pdf)
- Singh, G.K. & Yu, S.M. (1995). Infant mortality in the United States: Trends, differentials, and projections, 1950 through 2010. *American Journal of Public Health*, 85, 957-964.
- Smith, L.T. (2006). *Decolonizing methodologies: Research and indigenous peoples*. London, England: Zed Books.
- Spoonley, P. (1990). Polynesian immigrant workers in New Zealand. In C. Moore, J. Leckie & D. Munro (Eds.), *Labour in the South Pacific* (pp. 155-160). Townsville, QLD, Australia: James Cook University of Northern Queensland.
- Statistics New Zealand. (2001a). *2001 Census of population and dwellings: Pacific peoples*. Retrieved from <http://www.stats.govt.nz/census/2001-census-data/2001-census-pacific-peoples.aspx>
- Statistics New Zealand. (2001b). *Samoa people in New Zealand: 2001*. Wellington, New Zealand: Author.
- Statistics New Zealand. (2002). *Pacific progress: A report on the economic status of Pacific Peoples in New Zealand*. Wellington, New Zealand: Author.
- Statistics New Zealand. (2006). *QuickStats about Pacific people: 2006 census*. Retrieved from Statistics New Zealand - Tatauranga Aotearoa, Statistics New Zealand website: <http://www.stats.govt.nz/census/2006censushomepage/quickstats/quickstats-about-a-subject/pacific-peoples.aspx>
- Statistics New Zealand. (2007). *Samoa people in New Zealand: 2006*. Wellington, New Zealand: Author.

- Statistics New Zealand and the Ministry of Pacific Island Affairs. (2002). *Employment and income of Pacific peoples in New Zealand: Key statistics*. Wellington, New Zealand: Author.
- Statistics New Zealand and Ministry of Pacific Island Affairs. (2010). *Demographics of New Zealand's Pacific population: Pacific progress 2010*. Retrieved from Statistics New Zealand - Tatauranga Aotearoa, Statistics New Zealand website: [http://www.stats.govt.nz/browse\\_for\\_stats/people\\_and\\_communities/pacific\\_peoples/pacific-progress-demography.aspx](http://www.stats.govt.nz/browse_for_stats/people_and_communities/pacific_peoples/pacific-progress-demography.aspx)
- Sundborn, G. (2007). *Are standard low birth-weight categories appropriate for Pacific newborns?* Conference proceedings. Pasifika Medical Association. Apia, Samoa.
- Sundborn, G. (2010). *Cardiovascular disease risk factors and diabetes in Pacific adults: The diabetes heart and health study (DHAH), Auckland, New Zealand 2002/03*. Unpublished doctoral thesis, University of Auckland, Auckland, New Zealand.
- Sundborn, G., Metcalf, P., Scragg, R., Schaaf, D., Dyal, L., Gentles, D., ... Jackson, R. (2007). Ethnic differences in the prevalence of new and known diabetes mellitus, impaired glucose tolerance, and impaired fasting glucose. Diabetes Heart and Health Survey (DHAH) 2002-2003, Auckland New Zealand. *The New Zealand Medical Journal*, 120(1257), U2607. Retrieved from <http://www.nzma.org.nz/journal/120-1257/2607>
- Sundborn, G., Metcalf, P., Gentles, D., Scragg, R., Schaaf, D., Dyal, L., ... Jackson, R. (2008). Ethnic differences in cardiovascular disease risk factors and diabetes status for Pacific ethnic groups and Europeans in Diabetes Heart and Health Survey (DHAH) 2002-2003, Auckland New Zealand. *The New Zealand Medical Journal*, 121(1281), 28-39. Retrieved from <http://www.nzma.org.nz/journal/121-1281/3238/>
- Tautolo, E., Schluter, P., & Sundborn, G. (2009). Mental health well-being amongst fathers within the Pacific Island Families Study. *Pacific Health Dialog*, 15(1), 69-78.
- Thompson, J., Mitchell, E. & Borman, B. (1994). Sex specific birth weight percentiles by gestational age for New Zealand. *New Zealand Medical Journal*, 107(970), 1-3.
- Thompson, J. & Mitchell, E. (1994) Risk factors for small for gestational age infants: a New Zealand study. *New Zealand Medical Journal*, 107(973), 71-73.
- Trlin, A., & Watts, N. (2004). Chapter 6: Immigration policy and immigrant settlement: A flawed relationship at the turn of the millennium. In P. Spoonley, C. Macpherson & D. Pearson (Eds.), *Tangata Tangata: The changing ethnic contours of New Zealand* (pp. 111-134). Victoria, Australia: Thomson Dunmore Press.
- Tuagalu, I. (2008). Heuristics of the Vā. *Alternative: An International Journal of Indigenous Scholarship*, 4(1), 107-126.

- United Nations. (2008). *UNFPA annual report 2005*. Retrieved from <http://www.unfpa.org/about/2005/poverty.html>
- United Nations Children's Fund and World Health Organization. (2004). *Low birthweight: Country, regional and global estimates*. New York, NY: Author
- United States Department of State. (2008). *Background notes on Countries of the World: Samoa*. Retrieved from United States Department of State website: <http://www.state.gov>.
- Valdez, R., Athens, M.A., Thompson, G.H., Bradshaw, B.S., & Stern, M.P. (1994). Birthweight and adult health outcomes in biethnic population in the USA. *Diabetologia*, 37(6), 624-631. doi: 10.1007/BF00403383
- Valero de Bernabé, J., Soriano, T., Albaladejo, R., Juarranz, M., Calle, M.E., Martínez, D., ... Domínguez-Rojas. (2004). Risk factors for low birth weight: a review. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, 116(1), 3-15. doi:10.1016/j.ejogrb.2004.03.007
- Veloso de Veiga, P., & Wilder, R.P. (2008). Maternal smoking during pregnancy and birthweight: A propensity score matching approach. *Maternal and Child Health Journal*, 12(2), 194-203. doi: 10.1007/s10995-007-0238-8
- Wilcox, A., & Russell, I. (1990). Why small black infants have lower mortality rate than small white infants: The case for population-specific standards for birth weight. *The Journal of Pediatrics*, 116(1), 7-10.
- Wilcox, A.J. (2001). On the importance-and unimportance-of birthweight. *International Journal of Epidemiology*, 30(6), 1233-1241. doi: 10.1093/ije/30.6.1233
- Wright, S., & Hornblow, A. (2008). Emerging needs, evolving services: the health of Pacific peoples in New Zealand. *New Zealand Journal of Social Sciences Online*, 3, 21-33. doi: 1177-083X/08/0301-21