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Sia Tō'onga Mo'ui Study:

New Zealand Pacific Lifestyle Programme

A thesis presented in partial fulfilment of the requirements for the degree of

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Gavin Faeamani
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ABSTRACT

Objective and Rationale:

Pacific peoples in Aotearoa New Zealand (NZ) have the highest rates of type 2 diabetes (T2DM) compared to other population groups (1). There is a paucity in the design and implementation of culturally tailored approaches in NZ focused on targeting major long-term conditions, and particularly in reducing the T2DM epidemic among high risk population groups . This doctoral study investigates a culturally tailored approach focused on reducing the risk of developing T2DM. The objective of this study was to implement a culturally relevant lifestyle change programme, by adapting the efficacious Diabetes Prevention Programme (DPP), for use specifically amongst Tongans living in NZ. It also seeks to explore and understand the uptake and acceptability of the adapted prevention programme, including identifying the enablers and barriers of the programme in reducing the progression of prediabetes to T2DM in Tongan adults, aged 18-74 years old.

Methods:

The Sia Tō'onga Mo'ui Diabetes Prevention Programme (STM-DPP) uses a mixed-method approach and includes three phases. Phase 1: uses a citizen's panel approach, composed of three panel groups made up of: (i) community members, (ii) health experts, and (iii) representatives from the first two panels to adapt the Pacific Island Diabetes Prevention Programme (PI-DPP). Phase 2: involves the implementation of the newly adapted, now known as the STM-DPP by improving diet via weekly zoom sessions, and doing 150 minutes of physical activity every week, aiming to reduce 5% or more of total body weight. Data on clinical markers at baseline and post programme were collected and analysed to determine the impact of the STM-DPP. Phase 3 included an evaluation of the STM-DPP using focus groups aimed at examining successful processes, benefits, practical applications, behavioral, cultural, and motivational drivers of change.

Setting:

The study was conducted in Auckland, NZ. Focus group discussions on zoom was employed due to the restrictions of covid-19 at the time and associated lockdowns that restricted any

face-to-face or in-person meetings. The PI-DPP modules were also being presented weekly on zoom, with exercise sessions held at the two study site venues.

Results:

The citizens panels guided the adaption of the PI-DPP to reflect the Tongan culture and way of life; duration of the programme; consolidate and adapt the contents of the modules; appropriateness of programme delivery and approach; and incentives for participants. The implementation of the STM-DPP included 41 Tongan participants (males = 25, females =16), of which 95.2% had BMI≥30.0 and 75.6% with Prediabetes Risk Test (PRT) score of baseline PRT≥5 indicating a high risk. At the conclusion of the intervention, post-programme data revealed significant changes across all areas for participants in weight; waist to height ratio; physical activity capability; and blood pressure. The evaluation of the STM-DPP also report that the program's feasibility and acceptability among the Tongan communities were positive that explained the high uptake of the programme.

Conclusions:

These results provide evidenced-based research affirming that the culturally adapted T2DM prevention programme, STM-DPP, is feasible and acceptable amongst Tongans in NZ. The positive impact of the prevention programme among the Tongan population in Auckland could be made available and adapted to other Pacific populations across NZ.

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“Let us shout joyfully to the Rock of our salvation. Let us come before His presence with thanksgiving; let us shout joyfully to Him with psalms. For the LORD is the great God, and the great King above all gods. In His hand are the deep places of the earth' the heights of the hills are His also”. Psalm 95:1-5 (NKJV)

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Ofa lahi atu,
Gavin

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LIST OF ABBREVIATION

6MWT - Six Minute Walk Test

ADA - American Diabetes Association

ANZDATA - Australia and NZ Dialysis and Transplant Registry

aOR - Adjusted Odds Ratio

BF% - Body Fat Percentage

BMI - Body Mass Index

CBO - Community Based Organisation

CBPR - Community-Based Participatory Research

CDC - Centre for Disease Control and Prevention

CP#1 - Citizen Panel Number 1

CP#2 - Citizen Panel Number 2

CP#3 - Citizen Panel Number 3

CVD - Cardiovascular Disease

DHB - District Health Board

DPP - Diabetes Prevention Programme

EFA - Exploratory Factor Analyses

FFQ - Frequent Food Questionnaire

FGD - Focus Group Discussion

FPG - Fasting Plasma Glucose NHANES

GI - Glycaemia Index

GP - General Practitioners

GST - Goods and Services Tax

HbA1C - Hemoglobin A1C (blood test showing average blood sugar (glucose) level over the past two to three months

HOMA-IR - Homeostasis Model Assessment of Insulin Resistance

HWE - Healthy Workers Effect

IFG - Impaired Fasting Glucose

IHD - Ischemic Heart Disease

K-DPP - Kerala Diabetes Prevention Programme

LC - Lifestyle Coach

LCP - Lifestyle Change Programme

ML1 & ML2 - Maximum Likelihood

NCD - Non-Communicable Disease

NHANES - National Health and Nutrition Examination Survey

NHW - Non-Hispanic White

NPV - Negative Predictive Value

NZ - New Zealand

NZANS - New Zealand Adult Nutrition Survey

NZE - New Zealand Europeans

NZEO - NZ European and Other Ethnicities

OECD - Organization for Economic Cooperation and Development

OGTT - Oral Glucose Tolerance Test

OR - Odds Ratio

Paired - t tests - Tests for significance

PCOS - Polycystic Ovarian Syndrome

PDRT - Prediabetes Risk Test

PHO - Primary Health Organisation

PI - Pacific Island

PI-DPP - Pacific Island Diabetes Prevention Programme

PILI - Partnerships to Improve Lifestyle Interventions

PPV - Positive Predictive Value

PT2 - Prevent Type 2 (DPP Lifestyle Change Programme)

r - Pearson Correlation Coefficient

R - Programming Language and a Software for Statistical Computing and Graphics

RCT - Randomized Control Trial

SA-DPP - South African Diabetes Prevention Programme

SAS - Statistical Analysis Software

SBP - Systolic Blood Pressure

SD - Standard Deviations

SHAPE - South Asian Health and Prevention Education

STM-DPP - Sia Tō'onga Mo'ui Diabetes Prevention Programme

T2DM - Type 2 Diabetes Mellitus

USA - United States of America

WHO - World Health Organization

WHtR - Waist to Height Ratio

CHAPTER 1: INTRODUCTION

1.1 Rationale

Type 2 diabetes mellitus (T2DM) is a major global health issue of epic proportion. The health burden of T2DM on the health of Pacific peoples in New Zealand (NZ) is enormous and it is projected to grow over the next 20 years (2). Within NZ, 9.6% of Pacific peoples are affected disproportionately by T2DM, 4.6% for Māori, and 4.9% for Asians, compared to the total population prevalence of 4.6% (1). T2DM and cardiovascular disease (CVD) co-exist, increasing the risk of pre-mature death, although improvements have been made to stabilize these conditions and risks, challenges persist in establishing and implementing diabetes prevention programs, especially for Pacific peoples. These conditions lead to major health inequalities for Pacific peoples, driven by lifestyle changes, aging, and socio-economic factors like high deprivation, low income, and poor education. The health and community systems must respond differently and efficiently to address these determinants of health, particularly for Pacific peoples, where the cost associated with T2DM is estimated to be $2.1 billion per year, and is projected to increase by over 60% in the next 20 years (1). Such is the magnitude of this national and global epidemic, it cannot be ignored, because the health costs per person with T2DM (>$500, 000) will only increase as more younger people are diagnosed, compared to older people diagnosed with T2DM (<$45,000) (1).

1.2 Research Gap

As part of assessing cardiovascular risk in NZ, individuals are also screened for prediabetes. However, there is currently a fledgling emergence of lifestyle programs available for

individuals diagnosed with prediabetes in primary care or in the community (3). Thus, there is a lack of evidence-based research on how to engage and apply preventive programs to suit Pacific peoples and various ethnic groups, and encourage long-term improvements in health and wellness (4). Hence, there is an urgent need to address these health outcomes and inequities. Health promotion programs that have a prevention focus should ensure how to reach and include the most vulnerable and at risk members of the communities by creating equitable and successful health outcomes (5). These prevention programs should empower the communities to lead and take charge of their own health; and find ways to sustain these changes (6), and there is emerging and promising research tailoring prevention programs for specific long- term conditions such as T2DM amongst ethnic groups who have high prevalence rates of the disease (7) (8) (9) (10).

1.3 Significance of the Research

This study is highly significant since there are very limited lifestyle-based programs in the Pacific community aimed at preventing T2DM long-term. The findings of this current research study will offer significant knowledge for healthcare professionals, researchers, policy makers, and key stakeholders, regarding the development and accessibility of T2DM preventive programs for Pacific communities and primary healthcare providers. Moreover, it will strengthen the cultural safety and proficiency of professionals, while also promoting advocacy within the academics, researchers, and community. Furthermore, the findings of this study will attempt to address health disparities, particularly among Pacific populations at risk of T2DM. The current study's findings will provide evidence-based insights into how a T2DM prevention programme might be tailored to respond and reflect cultural and community circumstances, values, and protocols. It would also provide communities with the necessary

resources to take charge of improving their lifestyle habits and effectively preventing T2DM in the long-term, as the community and health specialists have co-designed the adapted PI-DPP. Such a collaboration would lead to favorable outcomes because the framework and approached piloted in this study could be used with other minority ethnic groups, including Māori, the Indigenous people of NZ.

1.4 Aims and Objectives

This study aims to pilot an adapted established diabetes prevention programme (DPP) that has been used among Pacific Islanders in the United States of America (USA), which is a lifestyle change programme called the Pacific Islander Diabetes Prevention Programme (PI-DPP) with a Tongan community in NZ; and to reduce the progression of developing T2DM. The current study also seeks to better understand the uptake, feasibility, and acceptability, and to identify enablers and barriers of using the lifestyle programme (PI-DPP), within a Tongan community context in NZ, so that other Pacific communities could replicate a similar approach.

There are two specific objectives to achieve the study purpose, to:

(1) – adapt and implement a culturally relevant lifestyle programme, the PI-DPP, for use in a NZ Tongan community among adults aged 18-74 years old, living with and an increased risk of prediabetes to reduce the progression to T2DM and;

(2) – explore and understand the uptake and acceptability of the adapted programme, including identifying the enablers and barriers of the programme.

1.5 Outline of the Chapters

The outline of this thesis includes seven chapters. Chapter 1 introduces the research topic; definition of T2DM, research gaps, aim and significance of the research. As this study focus on the prevention of prediabetes among a Tongan community in NZ, Chapter 2 provides useful background information on the Tongan people, migration, culture, and the impact of religion. It also discusses the context of the study. Chapter 3 discusses the literature review, T2DM and its risk factors, prediabetes, and the prevention programme landscape. Chapter 4 describes the methods underpinning this research and the three different phases: (i) adapting a well-established diabetes prevention programme, (ii) implementation of the adapted programme, and (iii) programme evaluation. Chapter 5 presents the relevant results of each of the three phases. Chapter 6 discusses the results and describes the significance and implications of the research findings. It re-examines the research objectives and identifies areas of future research. Finally, Chapter 7 draws conclusions about the importance of the ideas and issues engendered throughout this thesis and outlines future research and other recommendations.

CHAPTER 2: BACKGROUND

Before describing the context of the study, it is important first to acknowledge the origin of the Tongan people, their culture, the importance of religion, and how the church plays an important part in their lives as an important context factor for the success of this study. The Tongan people are very traditional and conservative in their cultural practices and day to day living. Knowing their history provides cultural and religious background information, which will contribute to understanding the wider context of the study (i.e., explaining why the research was carried out that could be different to future research/ers should they choose to replicate this approach and programme).

2.1 The origin of the Tongan people

The Kingdom of Tonga, a Polynesian archipelago, has a rich history dating back over 3,000 years. The Lapita people, who migrated from Southeast Asia, settled in the South Pacific and established settlements in Toloa and Heketa, which is on the man island Tongatapu (11). The early ancestors developed a distinctive culture that continues to underpin traditional Tongan life today. In 1845, the islands became the Kingdom of Tonga, which became a constitutional monarchy and British Protectorate. King George Tupou I united Tonga after many years of civil war, and his reign started in 1845, and in 1875 the Tongan Constitution was introduced. Tonga is the only island in the Pacific that has never been officially colonized by any other country and still is today. In 1970, Tonga joined the Commonwealth Nations and remained a monarchy. Those visiting the Kingdom of Tonga can experience the culture through dances, local art, handicrafts, and accommodations in resorts or village guesthouses (12).

2.2 A brief history of migration

The Kingdom of Tonga, a South Pacific Polynesian kingdom, has a rich history and authority, despite being a British protectorate for 70 years (13) (14). As an independent nation, Tonga is a constitutional monarchy. However, the kingdom's economy had been significantly transformed by internal and overseas migration, challenging its political position (14). In the 1930s, the Tongan population spread across the three island groups (Tongatapu, Ha'apai, and Vava'u) establishing 36 habitable islands. After World War II, the population distribution began to shift, with young Tongans moving to New Zealand, Australia, and the USA. This migration was a solution to the island's population growth, as the national population had swelled to 77,429 by 1966 and nearly tripled by 1976. The Tongan migration accelerated after 1965, reaching migration rates of over two percent annually. By the mid-1980s, over 1,900 were leaving Tonga each year, slowing the natural population growth rate to 0.3 percent by the census year 1996 (14). Today, half of the estimated 216,000 Tongans in the world live abroad, and almost every Tongan household has a relative resident in another country.

Tongan people have been a significant part of NZ's population for over 100 years, with their migration beginning in the 1940s. In the 1960s, more Tongans arrived on temporary permits to work in trades and tertiary institutions. Short-term contractual agreements between NZ and Tonga in the early 1970s brought an influx of unskilled workers for economic reasons. In 1974, the government took a tougher stance on Pacific Islanders who overstayed on their working visas, leading to some Tongans moving to Australia (15). In 1976, amnesty allowed many Tongans to be granted permanent residency in NZ, and by 2013, Tongans constituted 20% of NZ's Pacific population, with 250 Tongans granted permanent residency annually through the Pacific Access Category Resident Visa (15).

2.3 Tongan people and culture

For this study to be successful, knowledge and awareness about the Tongan people and their culture is critical. Some factors or elements of the culture are frequently cited as being extremely significant to “anga faka-Tonga” (i.e., Tongan customs and way of doing and being) (16) (17) (18) (19). For instance, the social structure of Tongan society which is highly stratified and status conscious. In general, those of lower status are expected to treat those of higher status with respect (faka'apa'apa) (20) (21) (22) and unwavering obedience. It is generally not acceptable to talk back (taungutu) (23) to people who are older or more privileged. Men and women are expected to fulfill specific roles and behaviors according to anga faka-Tonga and Tongan traditions, which also places a strong emphasis on gender, age differences, and family social structure. Compliance with anga faka-Tonga is frequently equated with carrying out oral traditions and obligations. Since many Tongan peoples’ identities are tied to their families and genealogies, sharing one's ancestry is particularly significant when meeting or collaborating with another Tongan person.

The migration of Tongan people overseas and away from their homeland can lead to changes in their cultural traditions and practices. Such changes have had a negative impact on their health, due to the Western culture and way of life influence. Tongan people constantly look for ways to preserve their culture or Tongan way of life (anga faka-Tonga). Despite the fact that some aspects of the traditional Tongan culture have changed as a result of the Western influence (24), Tongans highly value their families and social structures. Showing respect to elders and upholding their cultural traditions are examples of how they maintain strong connections to people and place. Tongan people are warm, friendly, and hospitable people, and their culture is an integral part of their identity.

The Tongan way places great value on a person's ties to their family and religion or Christian church. The idea of anga faka-Tonga also relates to Tongan beliefs, practices, values, and behaviors. The lives of Tongan communities and families living here in NZ are very busy in relation to work, family commitments, church activities, education, and sports activities. These commitments make life tough and difficult for individuals to commit to other things outside of their community, and anga faka-Tonga can set the priority for their lifestyle and wellbeing. The average total numbers in a household for Pacific Island families are quite high (25) (26) compared to other ethnic groups, and many struggle to make ends meet. Compared to any other ethnic groups in NZ, the Population Census 2013 reported that Tongan people had the highest population living in crowded houses at 48.7 % compared to the second ethnic group at 41.5%. Living in a confined space, particularly when it is very crowded, is associated with negative health effects, increased incidence of contagious illnesses, and limits the educational achievements and possibilities for their children. Research indicates that individuals living in densely populated homes have lower life satisfaction or quality of life, and are more prone to financial constraints when it comes to meeting basic necessities or seeking medical attention (27) .

2.4 Important role the church plays in the Tongan Community

The church plays a significant role in the lives of many Tongans, because it is a source of identity, unity, and was central to many Tongan families as they adapted to the new society (15), particularly as they are living in the diaspora of NZ, Australia, and the US. As more migrants arrived from Tonga from the 1950s onwards, new churches were established to provide for the spiritual and pastoral needs of establishing Tongan communities in NZ. With numerous churches across suburbs in Auckland, Tongan immigrants looked to the church as

a source for not only religious activities, but it also provided cultural and social practices linked to anga faka-Tonga. Not only that, these Tongan churches in Auckland had various committees within the church where church members with various skills come together and formed committees such as health, education, sports, and music, in order to assist families, youth and children who are struggling, and also to foster a sense of communal unity. In this way, the churches in Auckland mirrored the role that the village played in the lives of Tongans in their home islands.

Many churches were established in central Auckland specifically for Tongan immigrants, which included the Free Church of Tonga, Free Wesleyan, United Church of Tonga. Also, Tongan speaking churches were set up for Catholics, Seventh Day Adventists, Mormons, Baha'i, and many others to cater for the needs of the ever-growing Tongan communities. These churches were established and remain prevalent due to the efforts of many Tongan people who regularly contributed financially to the purchase and maintenance of their church infrastructure. The growth of these churches in Auckland highlights the importance of the church and spiritual wellbeing in the life of Tongans, and the desire to keep their connections strong and uphold their collective responsibilities to community and family. As the church is central to the collective living of many Tongan people in Auckland, designing and implementing a community-based programme would be ideal in this setting, because of the support from the church leaders, members, and the facilities (e.g., halls, kitchens) are important for the success of the programme being implemented for and with the community.

2.5 Pacific people in New Zealand

The term Pacific peoples refer to individuals who identify themselves with at least one or more of the ethnic groups from the Pacific Islands of Polynesia, Micronesia, and Melanesia. There are 23 different Pacific ethnic groups in NZ with various cultures, languages, and histories. For this study, I will be focussing on the Tongan population as they are now the second largest Pacific ethnic group in NZ (28) and my own network and personal affiliation with the Tongan community, being Tongan myself.

The latest NZ Population Census for 2018 shows Pacific peoples accounting for 8.1% (n= 381,642) of the total NZ population of 4,699,755. For all three District Health Boards (DHBs) areas in the Auckland Region, the total Pacific population accounts for 64.2%, with Counties Manukau DHB accounting 35.6%, Auckland and Waitemata DHB accounting for 15.4% and 13.2%, respectively.

The Tongan population of 82,389 accounts for 21.6% of the total Pacific Island (PI) population. The Tongan population across three DHB's mentioned previously accounts for 76.0% of the total Tongan Population in NZ. A breakdown in age group and gender are shown in *Table 1* for the three DHB areas. Over 37% are less than 15 years of age, while those who are 40+ years old accounts for 24.2% of Tongans in Auckland.

Table 1. Tongan Population by Age and Gender

DHB's		Male	Female	Total	% of Total Pop.
	Total NZ Tongan Population	**42,057**	**40,335**	**82,389**	
	Counties Manukau	17,427	17,112	34,539	41.90%
	Auckland	9,459	9,594	19,056	23.10%
	Waitemata	4,605	4,425	9,033	11.00%
	Total	**31,491**	**31,131**	**62,628**	**76.00%**
Age Group	*less than 15yrs*	12,141	11,277	23,421	37.40%
	15 – 24	6,129	6,201	12,336	19.70%
	25 – 39	5,730	5,997	11,730	18.70%
	40+	7,485	7,668	15,147	24.20%
	Total	**31,485**	**31,143**	**62,634**	**76.00%**

Note: some of the figures does not match due to missing or not further defined (nfd)
Source: http://nzdotstat.stats.govt.nz/

2.6 Context of the Study

Pacific communities in NZ have twice the rate of obesity compared to the total population. Obesity, defined as having a body mass index (BMI) more than 30kg/m^2, and it is regarded as an independent risk factor for prediabetes and T2DM. However, not all obese people develop prediabetes or T2DM. Approximately 32.2% of obese individuals are affected with prediabetes, and if no appropriate intervention is implemented, the chances of progressing to T2DM are significantly elevated (29). Presently, national preventive programs are tackling the burden of T2DM by focusing on making adjustments to individuals' lifestyles and behaviors (30) (31), but these are not always successful because they do not consider the cultural values of Pacific peoples, and given the description provided earlier about the structural systems of anga faka-Tonga and Tongan people, it is important that intervention programs have culture embedded within the programme. Therefore, there is a pressing need for health-promoting initiatives and intervention programs that include the cultural and socioeconomic structures of groups, that are at high risk of developing T2DM.

CHAPTER 3: LITERATURE REVIEW

T2DM is an important Non-Communicable Disease (NCD) that impacts the lives of many Pacific peoples in NZ. Hence, there is a need to investigate it further among our Pacific population, especially our Tongan people. The prevalence of T2DM among Māori and Pacific populations in New Zealand is almost three times greater compared to other populations within the country, with Māori and Pacific people having a prevalence of 7.5% and 15.1% (2018), respectively, compared to the national average of 4.6% (2018) (1). This chapter further contextualizes the literature landscape of the growing epidemic of T2DM, generally among Pacific peoples and specifically on available information on Tongan people and the impact on their health and wellbeing.

3.1 Type 2 Diabetes Mellitus (T2DM)

T2DM is the most prevalent kind of diabetes (32). It is primarily a condition brought on by the body's diminished capacity to effectively utilize insulin, leading to a steady decline in the production of sufficient quantities of insulin (33). Insulin is a pivotal endocrine hormone responsible for regulating the concentration of glucose inside the bloodstream (34). It facilitates the transportation of glucose from the bloodstream to the cells of the human body, enabling its use as an energy source (35). Overtime, potential long-term consequences encompass impairments to both major blood vessels (macrovascular) and minor blood vessels (microvascular), which may result in stroke; heart attacks; kidney failure; Alzheimer's disease; hearing impairment; sleep apnea; and deteriorating functioning of the eyes and feet (1).

The diagnosis of T2DM is based on a laboratory test measuring either HbA1c or venous plasma glucose measurements. Diagnosing T2DM requires an HbA1c test that is ≥ 50mmol/mol for adults, and for children it is an HbA1c ≥39mmol/mol according to the Australasian Paediatric Endocrinology Group guidelines (36). It is estimated that the number of people with T2DM in NZ will increase from 4.7% of the population (228,000 people) by 70% to 90% in the next 20 years, to 6.6% to 7.4% of the total population, approximately 390,000 to 430,000 people, as reported in The Economic and Social Cost of Type 2 Diabetes (1). This is due to the ever-increasing exposure to the obesogenic environment (37), and a lack of a system-wide response from the government, society and individuals and groups (1). The social costs of T2DM through loss of work, support payments and implicit costs caused by the impact of chronic disease on family and community life has been estimated as being more than the direct health care cost (38). Early-onset T2DM is an aggressive disease resulting in more complex complication networks than late-onset T2DM. Aggressive glucose-lowering intervention, complemented by lifestyle modifications are feasible strategies for controlling early-onset T2DM-related complications (39).

The WHO reported in 2023 that the prevalence of T2DM had a significant increase over the course of three decades, with a total population affected rising from 108 million in 1980 to 422 million in 2014 (40). There has been a noticeable rise in the prevalence of diabetes in low- and middle-income countries relative to high-income countries. The condition has a major role in the development of peripheral neuropathy, myocardial infarction, cerebrovascular accidents, and loss of vision in the lower limbs. There has been a discernible increased trend in diabetes-related fatality rates from 2000 to 2019, with a noteworthy 3% increase noted across various age groups.

3.2 T2DM in a New Zealand Context

A major challenge for people with T2DM is accessing adequate healthcare in NZ, particularly as currently the health system is even under more pressure with the lack of health professionals, associated costs to access services (including time) and personal motivation (41) (42) (43) (44). These are the leading drivers for health inequalities, particularly among NZ Pacific peoples (45). The estimated population prevalence of prediabetes is 18.6%, as reported by the 2008/2009 Adult Nutrition Survey, however, that survey was conducted 15 years ago, and the study sample was not representative of the general NZ population. For Pacific peoples, the current prevalence rate for T2DM in 2018 was estimated to be 9.6%, and has been projected to increase between 12.4% to 16.2% in 2040 (1). The prevalence for Asians was reported to be 4.9%, Māori at 4.6%, and Others at 4.2%, compared to the total population (4.7%). Glaringly, these statistics indicate that Pacific peoples and Māori are overly represented within the NZ T2DM population (1).

In regard to age, the group with the highest prevalence (15.4%) of T2DM is among the elderly group (80+ years). However, the age group with the highest projected growth over the next 20 years is the 60-79 year old group, where the prevalence is expected to rise from 12.9% in 2018 to 15.6% – 16.4% by 2040 (1). Since the population of NZ is aging, in 2040 the statistical trend indicates that there will be a higher percentage of persons in the older age groups than there were in 2018, and thus, age will be one of the main factors contributing to the increase in prevalence for the NZ population over time. Additionally, T2DM ranked seventh among the top 10 causes of health loss in NZ in 2019, contributing to early mortality, illness, and disability. It also contributed to 953 deaths in the year 2020, resulting in a mortality rate of 10.3 deaths per 100,000 individuals. Regarding the overall fatalities caused by this illness, the

mortality rate for Māori individuals was 29.5 deaths per 100,000 people, while for non-Māori individuals it was 8.5 deaths per 100,000 people. The mortality rate for women was 8.1 per 100,000 people, whilst for men it was 12.9 per 100,000 people (46).

A 2006 study conducted in NZ by Scott and others, reported significant differences in glycaemic control, microvascular complications, and complication screening among young people with T2DM. The mean HbA1c was 9.1±0.3%, with retinopathy and nephropathy prevalence rates of 12.8% and 17.1%, respectively, in their study sample (47). Māori and Pacific Islanders had more microalbuminuria over 12 years of age. The study highlighted difficulty in achieving good glycaemic control in children and young adults, thus implicating the need for earlier diagnosis of T2DM (47). Furthermore, a review by Joshy and Simmons (2006) examined the burden of diabetes in NZ, its risk factors, and complications, and the current national strategies to address the condition. Data from various sources, including the MEDLINE database, the Australia and NZ Dialysis and Transplant Registry (ANZDATA) Reports, and Ministry of Health publications were analysed (48). The study highlighted that Pacific and Māori populations showed a greater prevalence of risk factors for T2DM in comparison to Europeans. The study also examined the impact of diabetes complications and mortality, and concluded that a national strategic plan is necessary to monitor and control the rising incidence and prevalence of diabetes in New Zealand. This strategic plan should also address the proportion of individuals with undiagnosed diabetes, impaired glucose tolerance, and impaired fasting glucose (48).

3.3 Risk factors of T2DM

Genetic, environmental, and metabolic risk factors have an impact on the development of T2DM. Women diagnosed with gestational diabetes and their children have an elevated risk. Individuals who have a strong family history, are older, overweight and obese, and physically inactive, are also at an increased risk of developing the condition. Minority population groups face an elevated risk because of access to poor nutrition and low activity levels, and insulin resistance heightens the likelihood of developing impaired glucose tolerance and T2DM. Present therapies mostly target the alteration of environmental risk factors, such as mitigating obesity and advocating for physical activity. Increased knowledge of factors that contribute to T2DM risk support the idea of early screening, identification and implementation and treatment amongst high-risk groups.

A NZ research study by Robinson et al in 2006 compared general practice care for Pacific peoples mostly of Samoan, Tongan, Niuean, and Cook Islands ethnicities with T2DM in South and in West Auckland. The study was based on 5,917 patient audits from 2003. The findings indicated that individuals of Pacific and Māori descent with T2DM who visited a GP on a regular basis, have a higher number of consultations on average compared to individuals of European descent. In addition, Pacific peoples and Māori were found to have higher likelihood of possessing various risk factors for complications associated with T2DM, as compared to Europeans. These included those with an HbA1c of more than 8%, smoke, and have microalbuminuria. In addition, they found that although there were no notable disparities in the procedural aspects of general practice, Pacific and Māori people in South and West Auckland were not achieving comparable outcomes in terms of risk factors for

complications related to Type 2 Diabetes Mellitus (T2DM) care, when compared to other ethnic groups (49).

3.3.1 Modifiable risk factors

Risk factors for developing T2DM include obesity (BMI>30kg/m^2), lack of physical activity, poor diet, smoking, and alcohol/drug consumption.

(a) Overweight and obese

Researchers have established that being overweight or obese raises the risk of T2DM (50) (51). However, not all overweight and obese people go on to develop T2DM (52) . It has also been established that T2DM can be considerably lowered by losing 5% to 10% of your total body weight in addition to engaging in regular physical activity (53). New Zealand has notably high rates of overweight and obesity in children (>5 years old) and adolescents, with a higher incidence among certain ethnic groups, such as Pacific and Māori, especially those from poorer socioeconomic backgrounds (54). For the benefit of present and future generations, NZ should prioritize reducing the existing burden of childhood obesity (54). Future health strategies should concentrate on preventing obesity, especially in the young and by identifying individuals who are most vulnerable, by implementing screening opportunities and implementing lifestyle change programmes earlier, particularly in childhood years, where early intervention can affect more positive changes, than in adulthood.

Obesity is considered a major risk factor for a range of metabolic syndrome conditions, and particularly for T2DM. Pacific peoples in NZ have the highest rates of obesity (i.e. BMI >30kg/m^2) of 67% among people aged 15 years and older, compared to Māori (47%), and the

general population (32%) (55). Of note, NZ has the third highest adult (i.e., 15 years and older) obesity rates among countries who are part of the Organization for Economic Cooperation and Development (OECD) (56), behind the USA and Mexico. Obesity is one of the leading causes of health loss (43), because it lowers quality of life, raises health care costs, and it is a known independent risk factor for a variety of chronic long-term conditions and disabilities(57)) (58) (59). Among NZ children, 12.4% of children and adolescents aged 2–14 years are considered to be obese, with a further 19.6% being overweight. Compared to European/Other and Asian children, Māori and Pacific children have the highest rates of obesity. Specifically, the adjusted odds ratio (aOR) of obesity was 1.56 (95% CI 1.23, 1.97) for Māori children, and 3.07 (95% CI 2.43, 3.86) for Pacific children (54). Obesity is a complex, and multi-factorial condition, based on the interaction of genetic, metabolic, social, behavioural, and cultural factors (60).

There is a growing acceptance that the current generation and those born 40 years ago have had the biggest exposure to what has been coined as the 'obesogenic environment', and this has contributed significantly to the obesity epidemic. It is an environment that promotes over-eating, high consumption of drinking sugar sweetened beverages and limited opportunities for physical activity. The obesogenic environments include four environments: the physical, economic, policy and socio-cultural environment (61) (62). The physical environment encompasses the visible world, as well as the less tangible factors, such as the availability of training, nutrition, and exercise opportunities. The economic environment refers to the costs related to food and physical activity. The political environment refers to the rules and policies related to food and physical activity and includes the laws, regulations, policies, and institutional rules for engagement. The sociocultural environment refers to a

community or societal attitudes, beliefs, and values regarding food security and physical activity. These environments highlight the surroundings, opportunities or conditions of life that has the propensity to promote obesity in individuals or populations (37). Arguably, the life-long exposure to the obesogenic environment has contributed to the high prevalence of obesity among the younger generation of New Zealanders(63).

The research literature has highlighted the complexity and wickedness of the obesity epidemic (64), yet there have been no real tangible or pragmatic approaches from a public health perspective on how to reverse this epidemic (65). More recently, in NZ there has been a push for the removal of goods and services tax (GST) off fruit and vegetables to enable those population groups living in the lowest deprivation to access these food types more readily (66). However, with the recent inflation rise in NZ and economists disregarding the removal of GST on these products, the costs of adjusting the NZ GST system is more than the benefits of removing GST on fruits and vegetables (67). Therefore, public health researchers and health promoters are still not in a position to adequately address the diet-related issues of obesity and its multifactorial web of complexity that impacts behaviour. Nonetheless, it is still important to keep these issues at the political forefront to ensure that there is ongoing dialogue between researchers and those that can enable policy translation.

(b) Lack of physical activity

Another modifiable risk factor for T2DM and prediabetes is physical inactivity. Insulin resistance can be lowered with regular exercise. This implies that one's body will be able to utilize insulin more efficiently. It has been demonstrated that engaging in even a brisk 30-minute walk five days a week can considerably lower the diabetes and risk of heart disease

(68). Whilst other research has shown that vigorous and non-vigorous physical activity are both associated with high insulin sensitivity, and that increased moderate-intensity of physical activity on most days is highly recommended (69). Earlier research based on experimental and epidemiological studies in low, middle and high income countries, reported life-course evidence, that regular activity and dietary factors that include omega-3 fatty acids, low glycaemia index food types and being exclusively breastfed at infancy was essential to T2DM prevention, with the aim of reducing total saturated fat intake by 7% of the total energy consumption (70).

(c) Poor diet

Consuming nutritious foods in appropriate quantities is crucial to the prevention of T2DM. Diet plays a crucial role in influencing the risk of developing prediabetes and T2DM. The American Heart Association suggests a diet consisting of fruits, vegetables, whole grains, skinless poultry, fish, legumes, non-tropical vegetable oils, unsalted nuts, and seeds (71). A nutritious diet should substitute saturated fats with monounsaturated and polyunsaturated fats, eliminate trans fats, lower cholesterol and sodium intake, and restrict consumption of red and processed meats, refined carbs, and sweetened beverages (71). A recent systematic review with meta-analyses of 53 prospective observational-based studies was conducted in 2019, and the authors highlighted some dietary factors (i.e., whole grains, cereal fiber, and moderate total alcohol intake) as being strongly associated with a reduced incidence of T2DM, and therefore these play an important role in the prevention of T2DM (72). The same authors pushed for more studies of better quality and detailed dietary analyses was needed to identify specific dietary markers for T2DM prevention, and although this is important

knowledge, how to transform this into realistic actions for high risk population groups has been complex and difficult, and requires significant applied behavioural change strategies.

(d) Smoking and alcohol consumption

Smoking is a significant risk factor for diabetes, increasing the risk of T2DM and cardiovascular disease. It causes glucose intolerance, impaired beta-cell function, inflammation, and endothelial dysfunction, worsening clinical outcomes (73). Various studies have confirmed the theory that excessive alcohol consumption raises the likelihood of developing T2DM in middle-aged males. Moderate alcohol use does not raise the risk of T2DM in middle-aged men or women (74). In contrast, the researchers have noted that moderate alcohol intake as being positively associated with reducing the incidence of T2DM (74).

(e) Lack of sleep, stress and well-being

Sleep has positive effects on various parts of the body, such as the heart and brain. It enhances mood, memory, and cognitive abilities. Research indicates that inadequate or excessive sleep is associated with elevated A1C levels in individuals with T2DM (75). Any disruptions in sleep quality or quantity might lead to a higher occurrence of T2DM and other metabolic conditions (76). Impacted sleep can pose negative cognitive and neurobehavioral problems that results in sleep deprivation, fragmented sleep, and daytime sleepiness. Strine and Chapman (2005) reported 26% of adults who experience more than two weeks of inadequate sleep, self-reported poor health status and poor mental health conditions (77). Similarly, they found that people with less-than-optimal sleep were significantly more likely to smoke, have limited physical activity, consume more alcohol and be obese. In the Whitehall II study, 'over-sleepers' and 'short-sleepers' (in regards to sleep duration), had a

1.3-1.7 times higher odds of developing T2DM, compared to those people who maintained a 7-8 hours' sleep a night (78). Most epidemiological studies rely on self-reported sleep duration (long- and short- sleepers) and T2DM, which can introduce information bias, particularly where there is no objective measurements to assess the association (79). Although, sleep conditions such as Obstructive Sleep Apnoea (i.e., when a person stops breathing whilst sleeping) have stronger associations with T2DM because they share similar risk factor profiles (i.e., obesity, increased waist circumference) (80) (81).

3.3.2 Non-modifiable risk factors

Factors such as age, race/ethnicity, and family history, in addition to genes, increases the likelihood that an individual may be diagnosed with T2DM. Some racial/ethnic groups are also more susceptible to developing T2DM. People of Asian, Māori, and Pacific descent have a higher risk of developing the condition, compared to other ethnic groups in NZ, particularly those at a younger age (82). The younger generation inherit certain risk factors for diabetes from their parents or close biological relatives, increases the likelihood of also developing T2DM. Also, having a parent or sibling with T2DM further increases the risk of developing the disease. Women with polycystic ovarian syndrome (PCOS) or a history of prediabetes, gestational diabetes, or another kind of diabetes are also at an increased risk of developing T2DM (83).

3.3.3 Circumstantial Factors

Various factors such as socioeconomic deprivation and long-term mental illness are associated with T2DM(1). As obesity is more prevalent among those with lower socioeconomic status compared to those with greater socioeconomic status (84), in

impoverished social classes, studies have shown that their dietary quality are reduced, characterized by higher consumption of fat and simple carbohydrates (e.g., white bread), and lower intake of fruits, vegetables, and wholegrain food (85). Furthermore, low-income neighborhoods lacking exercise facilities and access to green spaces (e.g., parks and recreational spaces) have also shown to have an association with high rates of physical inactivity. Individuals with lower socioeconomic status may experience metabolic implications that are connected to insulin resistance, and this has been discussed earlier under 'obesogenic environment'. Additionally, in 2014 Ribe and others, noted that individuals living with severe mental illness (SMI) and co-existing T2DM had a high mortality rate, which in part, was explained by complications and challenges of managing their T2DM (86). Patients with T2DM and co-morbidities often struggle to control and manage their conditions with multiple health appointments and medications, thus placing them at high risk for health challenges and poor outcomes (87).

3.3.4 Prediabetes

Pacific peoples, Māori, and Indo-Asian individuals have a disproportionately high prevalence of diabetes and pre-diabetes, which puts them at an increased risk of T2DM and its associated comorbidities. Prediabetes is defined as having a haemoglobin A1C (HbA1c) between 41-49mmol/mol (5.8-6.7%) for adults aged 15 years and older, but it is not sufficiently elevated to be diagnosed with T2DM (29) (41). The prevalence of prediabetes is high in NZ adults (25%) (29). Based on the analysis of the 2008/2009 Adult Nutrition Survey data, Coppell et al. (2013) noted that, 32% of the general NZ population have prediabetes (29), and it is especially elevated in Pacific peoples, with 13.6% of Pacific youth aged 15-24 years have prediabetes compared to 7% in NZ Europeans (NZE). While among the Pacific working-age adults (25-

44years) 29.6% (vs. 16% in NZE) have prediabetes. Older Pacific adults aged 65-74 years have an even higher prevalence of this condition (56.9% vs. 44.5% among NZE) (29), and given their age and potentially having other comorbid conditions, they have a high risk of mortality and diabetes related complications (29). Very little is known about the Pacific peoples with this condition, and how they manage lifestyle challenges imposed by this prediabetes.

People with prediabetes do not necessarily develop T2DM, however, 70% are likely to progress to developing the condition later in their lifetime (88). The early onset of prediabetes results in worse health outcomes and possible increased morbidity risk and decreased life expectancy. Individuals with prediabetes often have the following symptoms: extreme thirst, needing to urinate frequently, dry skin, feeling hungry, blurred vision, feeling drowsy, and their wounds are slow to heal (1) (89). Not all people with prediabetes will experience these symptoms, but the increase in glucose levels can lead to serious health complications, such as the increased risk damage to the blood vessels, heart, and kidneys (88). Nonetheless, research on lifestyle intervention (especially through physical activity and dietary modifications) have shown to be very successful in reversing the disease.

3.4 Addressing T2DM in NZ

In NZ, preventive programmes addressing the T2DM burden through lifestyle and behavioural changes (26, 27) have shown some success in reversing symptoms of T2DM (90) (91). The National Diabetes Work Programme 2014/15 has identified lifestyle behaviours as an important focus for managing prediabetes, including developing goals, weight management and repeat HbA1c measures at 3 and 6 months post-lifestyle intervention (6). Other localised projects report well known barriers and challenges, including the lack of time to attend

appointments and programmes; financial limitations; poor location of the programme, meaning people cannot attend them due to geographical barriers; lack of time and education about the programme purpose; inadequate access (e.g., no public transport or multiple routes to get to the destination), low health literacy; attrition in participation due to loss of interest in the programme; and lack of support by family members or friends attending the programme (92) (93) (94). In addition, Māori and Pacific peoples were less likely to continue participating in these programmes due to cultural and language issues, limited finances, de-motivation, and the inability to commit long-term (92) (95) (94). Thus, adapting existing successful prevention programmes and changing the social environment to tailor to high-risk population groups challenges are essential to support sustained behavioural lifestyle changes to improve health and reduce more severe complications of T2DM.

3.5 General Practice and Prediabetes

Prediabetes affects approximately 20% of the New Zealand adult population (96). Prediabetes is ultimately considered reversible and if this cannot be achieved, a secondary goal is to delay progression to T2DM with its long-term complications. General Practitioners (GP) are very aware to screen for this condition if risk factors are detected. Risk factors include obesity (especially abdominal obesity), hypertension or hyper lipidaemia. Diagnosis is via a blood test of HbA1c:41 to 49 mmol/mol diagnostic result of prediabetes. These patients are usually recalled for discussion and education, and emphasis is placed on this condition being reversible with lifestyle management and the patient empowered to make changes to benefit their long-term health.

Lifestyle management focuses on the following main issues:

(1) Weight loss: any weight loss is encouraged. A weight loss of 5 – 10% may reverse prediabetes.

(2) Healthy eating: particularly cutting out sugar from the diet and reducing carbohydrate intake to recommended levels (plate model).

(3) Increasing physical activity: do as much physical activity as possible aiming to achieve 30 minutes of moderate activity every day, five days of the week.

(4) Quit smoking.

(5) Reduced alcohol intake to recommended health guidelines (97).

Follow-up appointments with the family GP and or a diabetes specialist is important for maintaining focus on this condition as most patients are asymptomatic. Annual blood glucose testing is recommended to track progress, and patients with higher levels of HbA1c (range> 45 mmol/mol) may need follow-up tests every three or six months depending on personal risk factors (e.g., strong family history, comorbid hypertension, hyper lipidaemia) (96).

3.6 Previous approaches to diabetes prevention

In the USA, the Centre for Disease Control and Prevention (CDC) have endorsed the Diabetes Prevention Program (DPP), which has proven to be effective in implementing a lifestyle intervention program. This program was tested in a randomized clinical trial conducted across 27 study sites and targeted those at a high risk of developing T2DM. The lifestyle intervention, which involved a 5-7% reduction in total body weight and 150 minutes of activity per week, resulted in a 58% drop in the incidence of T2DM compared to a 31% decrease in the group treated with metformin. The CDC also introduced incentives that empowered patients to

complete the programme through their respective health insurance schemes which proved to be very successful. Such incentivisation's are important to factorise into any intervention programme, as merely seeing a behavioural change in weight loss or feeling better is insufficient to sustain the amount of effort and commitment to a lifestyle change program (LCP).

The DPP was modified to incorporate bodyweight and physical activity (98). Even after a decade, those who participated in the program had a 33% lower likelihood of developing diabetes compared to those who did not participate. This approach has also demonstrated a reduction in the likelihood of experiencing a heart attack or stroke, a reversal of a prediabetes diagnosis, and an enhancement of overall health. Studies have demonstrated comparable trends in reducing the risk of diseases when lifestyle programmes incorporate nutrition and physical activity (99) (100). These strategies are widely recognized as effective preventive measures for reducing risk factors associated with cardiovascular diseases, such as high body mass index, and hypertension. Similarly, in NZ, preventative programmes that focus on lifestyle and behavioural modifications (101) (102) have demonstrated some efficacy in reversing T2DM and reducing the risk of CVD (103) (91).

The National Diabetes Work Programme 2014/15 has recognized lifestyle behaviours as a crucial area of focus for addressing prediabetes. This included goal setting, maintaining weight, and conducting repeat HbA1c measurements at three and six months after lifestyle interventions (41). Local initiatives (104) (94) documented commonly encountered obstacles and difficulties, such as insufficient time availability, limited financial resources, unfavourable program locations, lack of educational background, waning interest, and absence of support

from family or friends, as being the main barriers to access or continue with the program (104) (94). Furthermore, Māori and Pacific individuals had lower rates of program retention as a result of cultural and linguistic barriers, financial constraints, lack of enthusiasm, and an inability to sustain long-term commitment (94). Therefore, it is crucial to modify existing effective intervention programs and adjust the social environment to cater to high-risk population groups such as the Pacific Island and Māori population. This is necessary to facilitate long-term behavioural lifestyle changes that can improve heart health and decrease the likelihood of premature mortality from CVD risk.

3.7 Community-based interventions

Community-based participatory research (CBPR) is a recognised approach that brings together communities and researchers to improve health collaboratively in the community. Previous NZ-based CBPR prevention programmes (105) (106) have highlighted the need for programme delivery to be more culturally specific including addressing of language barriers.

Despite the government's commitment to reducing the incidence and disease impact of T2DM through health service targets, prevention programmes remain as the key issue in tackling these conditions, and in particular, a culturally tailored approach, implemented in the community setting (1). A major knowledge gap is *knowing how to tailor* equitable prevention programmes for sustainable healthier lifestyle changes. Ideally, such programmes are capable of delivering effective and equitable public health programmes and activities that are accessible to and its uptake by population groups that have the highest risk and needs (5). These programmes should empower communities to become independent advocates for healthier lifestyle changes and identify strategies to sustain these changes (107).

A number of research has shown success in tailoring or adapting the DPP to fit some of the at risk ethnic groups such as Pacific people, Asians, Hawaiian, and Indians (108) (109) (110) (111) (112) (113) *(see Table 2.).* Internationally, Native Hawaiian researchers had culturally adapted the efficacious DPP work, called the Partnerships to Improve Lifestyle Interventions (PILI) Study to address obesity disparities. The PILI Study resulted in 51% of Native Hawaiians and other Pacific peoples achieving 3% or greater weight loss over nine months, compared to 31.4% of those in the standard behavioural programme (control group), with a mean weight decrease of 2.54kg (sd=7.0) vs. 0.45kg (sd=9.7), respectively (114). They also reported that initial weight loss in the first three months of the PILI study predicted nine months weight loss [OR=1.47(per 1 kg change), 95% CI: 1.22-1.86, p<.001), after adjusting for correlation across socio-demographic, behavioural, and clinical factors (114) (115). Those who achieved early weight loss success were most likely to benefit long-term, which is consistent with other studies (116) (117) (118) (112).

Aitaoto and others (2017) adapted the DPP Lifestyle Change programme (PT2) among USA Pacific Islanders (called the PI-DPP) across five sites in the US and in the Pacific region. The PI-DPP is a US national program that builds the infrastructure of local organizations to deliver Pacific Island-tailored, and CDC-recognized lifestyle change programs (LCP) to Pacific Islanders, Medicare beneficiaries, and the general population in the US. Unpublished data have indicated results exceeding that of the DPP study by more than two-fold after participating at six months on the programme, compared to the mainstream average at 12 months post-prevention (personal communications, Aitaoto 2020). Participant attrition rates for these implementation sites at the end of the 12 months prevention programme were

reported between 13-18% (119). For the current doctoral research project, this work will run parallel to the PI-DPP, where both projects will leverage off each other, in developing strong Pacific evidence-based research to reduce T2DM risk and improve overall health.

A study by Beasley et al. (113) explored and modified the CDC and DPP for elderly individuals with the aim of preventing T2DM. Two sessions of the adapted content were delivered by video conference to 189 older adults, which was led by a trained lifestyle coach. The results indicated a substantial response rate, with 85% of participants expressing a positive opinion of the virtual programme. They used their data to conduct a randomized controlled study that compared the in-person and virtual delivery of the modified curriculum (113) .

The South African Diabetes Prevention Programme (SA-DPP) utilised a combination of qualitative and quantitative methods in a systematic approach to develop and enhance its curriculum and tools for underserved communities with limited resources. The SA-DPP is a lifestyle preventive initiative implemented in South Africa, specifically tailored to assist individuals at high risks of T2DM (108). The SA-DPP utilised a combination of qualitative and quantitative methods in a systematic approach to develop and enhance its curriculum and tools for underserved communities with limited resources. The method involved examining current evidence, holding focus group conversations, and seeking advice from specialists. During this process, experts thoroughly examined the resources which included content of the curriculum booklet, as well as the participant and facilitator workbooks. The design and layout were suitable for the culture and context. The printed material underwent assessment for readability and acceptability by the target audience, leading to adjustments in the design. The programme was piloted, and the curriculum was adjusted accordingly. An in-depth

assessment of this culturally approach for preventing T2DM in South Africa is still pending (108).

The study conducted by Park et al. (109) in 2022 was to determine the characteristics of a group of Samoans and Tongans in Southern California who are at risk for T2DM. Additionally, the study aimed to evaluate the barriers, cultural determinants, and willingness to adopt a culturally adapted DDP in a religious setting. The pilot study employed an adapted DPP sessions, questionnaires, and focus group, targeting Samoan and Tongan church members who expressed an interest in adapting their lifestyle behaviours. The findings highlighted that 98% of participants were classified as overweight or obese, whereas 45% of households experienced food insecurity. Of the total respondents, 28% said they could speak English only very poorly or fair, and less than half were born in the United States. It was found that higher body mass index scores were associated with poorer levels of self-efficacy and internal control for healthy eating, as well as motivation to lose weight in order to feel more in control of their health. Focus groups have indicated that the Samoan and Tongan communities are not receiving adequate services and do not have access to programmes that are culturally appropriate for addressing obesity and chronic diseases. The study found challenges to adopting healthier lifestyles included stress, cultural values, limited awareness about healthy lifestyles, and the adaptation of traditional recipes.

Additionally, the church context was recognised as a resource that could be further exploited to improve health outcomes (109). The reduction of its risk factors has been demonstrated to be effective through lifestyle modification. However, there has been a lack of effort to adapt intervention programmes for T2DM prevention in low- and middle-income countries, for

example, India has the world's second-largest number of individuals living with T2DM (101 million) and 136 million people with prediabetes (120) (121) However, due to the large scale of numbers of people with the disease, without a national prevention programme, treating and managing this large number of people becomes highly unmanageable, and the healthcare costs associated with T2DM complications are not affordable for more than 95% of the population (122). This research gap is a major challenge to T2DM prevention and control.

Based on evidence-based lifestyle prevention programme, the Kerala Diabetes Prevention Programme (K-DPP) was developed from high-income nations including Finland, the US, and Australia. The K-DPP programme includes four components; resource materials; approach to promote wider community involvement; a peer-leader training and support programme for lay people to lead groups; and a group-based peer support system for participants. The K-DPP is India's first peer-led, community-based diabetes prevention programme which has been thoroughly evaluated. Subsequent improvements and implementations may facilitate the adaptation of K-DPP to diverse settings and demographics in India and other low- and middle-income nations (120).

The study by Yin et al in 2018 (111) sought to assess the practicability and efficacy of an evidence-based program for preventing diabetes in Yuci, Shanxi Province, China, during the period of 2012 to 2014. A group of women between the ages of 25 and 65 years old with prediabetes, were randomly divided into two groups: group one received a lifestyle intervention for six months, while the other group served as a comparison (control). The results indicated that across all variables, with the exception of fasting glucose, the lifestyle intervention group demonstrated positive improvement during the six and twelve month

follow-up periods, for both groups. The intervention group exhibited more weight loss, and a lower body mass index compared to the comparison group. At follow-up, 31.6% and 16.2% of participants in the intervention group successfully achieved a 5% weight loss objective (111). There was no notable disparity across groups in outcome measures during the 12-month follow-up. The intervention group participants also showed positive alterations in self-reported dietary and physical activity assessments. The study found that implementing a lifestyle intervention to prevent diabetes in women at risk, inside community health centres in China, was both feasible and acceptable (111).

A study conducted by Weber, Hennink, and Narayan (2020) (110) sought to create and evaluate the practicality of a culturally customised DPP for US South Asians, a significant community at a heightened risk of T2DM. The South Asian Health and Prevention Education (SHAPE) project encompassed focus group deliberations, adaptation of the US DPP for South Asians, and a pilot investigation to evaluate the program's impact. The findings demonstrated favourable improvements in participants' weight, waist circumference, blood pressure, plasma lipids, HbA1c, and other cardiometabolic indicators after the intervention. Additionally, 55% of patients achieved normal blood sugar levels. The study emphasised the practicality of culturally adapted programmes and their beneficial effect on preventing diabetes in the South Asian community.

Table 2. A summary of previous DPP studies

Year	Study	Sample	Methodology	Results
2023	Beasley JM, Johnston EA, Costea D, Sevick MA, Rogers ES, Jay M, Zhong J, Chodosh J. A*dapting the Diabetes Prevention Program for Older Adults: Descriptive Study*. JMIR Formative Research. 2023 Aug 29;7(1): e45004.	N = 189	The research team modified the program to include supplementary resources that were deemed essential for the elderly population. 189 older individuals were presented with two sessions of the adapted content via videoconference by a certified lifestyle coach.	The survey received 34.9% (38/109) of the total responses during the first session, and 34% (30/88) during the second. A majority of the respondents (85%, 50/59) expressed satisfaction with the virtual program, and 82% (45/55) said they would definitely recommend it to a friend or family member.
2023	Hill J, Faber M, Peer N, George C, Oldenburg B, Kengne AP. *Adapting and Developing A Diabetes Prevention Intervention Programme for South Africa: Curriculum and Tools.* International Journal of Environmental Research and Public Health. 2023 Mar 2;20(5):4463.	Two series of FGDs (n = 17) were conducted with n= 68 participants. Participants were mostly female (n = 50), between the ages of 45 and 65 years old (n = 58), and predominantly Xhosa speaking (n = 42) rather than English/Afrikaans speaking (n = 26) participants. First focus group discussion (n=10) Second focus group discussion (n=7)	Qualitative mixed-method staged approach.	A context specific intervention and printed materials were developed. A complete evaluation of this culturally relevant model for T2DM prevention in South Africa is pending.
2022	Parks CA, Panapasa SV, Yaroch AL, Fricke HE, Resnicow K. *Diabetes prevention for Pacific people in the United States: A mixed-methods feasibility study to adapt the diabetes prevention program with Samoan/Tongan church communities.* Journal of Public Health Management and Practice. 2022 Jan 1;28(1): E185-93.	Ethnic = Samoan/Tongan church members in Southern California who were interested in lifestyle behaviour change. Participants = 47	Mixed-methods pilot	The study suggests ways to customize the DPP for US-based Samoan/Tongan populations by utilizing cultural traditions, addressing existing barriers, and enhancing psychosocial constructs.
2020	Weber MB, Hennink MM, Narayan KV. *Tailoring lifestyle programmes for diabetes prevention for US South Asians.* Family medicine and community health. 2020;8(2).	Focus Groups = 17 Participants = 109 Ethnic = US South Asians	Qualitative (1) focus group discussions with South Asian adults to understand views of lifestyle behaviours and diabetes prevention; (2)	The study highlights the challenges faced by US South Asians in adopting standard lifestyle change programs, highlighting the

			modification of the US DPP for South Asians; (3) a pilot, pre–post study to test the feasibility and impact of delivering the culturally tailored programme	potential of culturally tailored diabetes prevention initiatives.
2018	Yin Z, Perry J, Duan X, He M, Johnson R, Feng Y, Strand M. *Cultural adaptation of an evidence-based lifestyle intervention for diabetes prevention in Chinese women at risk for diabetes: results of a randomized trial*. International health. 2018 Sep 1;10(5):391-400.	Participants were women with pre-diabetes, ages 25–65 yrs., Comparison Group, n = 75 Lifestyle Intervention Group n = 109	Randomised Control The study measured weight, fasting glucose, haemoglobin A1c, self-reported diet, and physical activity at baseline, 6 months, and 12 months.	Diabetes prevention in at-risk women in China's community health centres is feasible and acceptable, but effect sizes are small.
2017	Mathews E, Thomas E, Absetz P, D'Esposito F, Aziz Z, Balachandran S, Daivadanam M, Thankappan KR, Oldenburg B. *Cultural adaptation of a peer-led lifestyle intervention program for diabetes prevention in India: the Kerala diabetes prevention program* (K-DPP). BMC Public health. 2017 Dec;17:1-3.	Three focus group discussions were held, each with six participants (n = 18; age range 33-64 years)	Qualitative Adaptation process was undertaken in five phases: 1) needs assessment; 2) formulation of program objectives; 3) program adaptation and development; 4) piloting of the program and its delivery; and 5) program refinement and active implementation.	K-DPP, includes four key components: 1) a group-based peer support program for participants; 2) a peer-leader training and support program for lay people to lead the groups; 3) resource materials; and 4) strategies to stimulate broader community engagement. The systematic approach to adaptation was underpinned by evidence-based behaviour change techniques.
2017	Presentation by Associate Professor Nia Aitaoto. *"Pacific Islander Diabetes Prevention Program"* Aitaoto N. PI-DPP. Salt Lake City, US: University of Utah; 2019. 2019.		Tailoring done through collective participation & requires trust via assembled community stakeholders and trusted subject matter experts	Successfully tailored the DPP to PI-DPP so it's accessible to Pacific Islanders in the US who are termed as high risk. A number of resources has been developed including the translation of the PI-DPP into the different Pacific Island languages
2010	Mau MK, Kaholokula JK, West MR, Leake A, Efird JT, Rose C, Palakiko DM, Yoshimura S, Kekauoha PB, Gomes H. *Translating diabetes prevention into native Hawaiian and Pacific Islander communities: the PILI 'Ohana Pilot project. Progress in community health partnerships*: research, education, and action. 2010;4(1):7.	N = 239 Native Hawaiian/Pacific Islander adults completed the translated DPP-LI through four community-based organizations (CBOs)	Mixed method	All indicators showed significant improvements, with variations noted throughout the four CBOs. There was a higher rate of weight loss in CBOs with intervention groups that were primarily Native Hawaiian and ethnically homogeneous.

				Native Hawaiians and residents of Pacific Islands may find the translated DPP-LI useful, particularly when sociocultural, socioeconomic, and environmental issues pertaining to CBO are considered.

There is growing evidence demonstrating that adapting the DPP is feasible and its uptake for the intended group it had been adapted for has also shown to be successful. The findings from this doctoral study will inform health providers, researchers, and community stakeholders on how to best develop and adapt the DDP with a specific Pacific Island community.

CHAPTER 4: METHODS

This project is an implementation study, which aims to explore the feasibility and acceptability of an adapted Pacific Islander Diabetes Prevention Programme (PI-DPP), using a community-based approach. This study has a mixed method approach, both qualitative and quantitative to measure feasibility, uptake, and effectiveness of the adapted programme. Methods 1 and 3 are qualitative while Methods 2 is quantitative. Methods 1 is the *"adaption of the PI-DPP"*. Methods 2 describes the *"implementation of the adapted PI-DPP"*; and Methods 3 describes the *"Evaluation of the adapted PI-DPP"*.

Of note, I had received the Lifestyle Coach (LC) training 12 months with my co-supervisor Assistant Professor Aitaoto, who is a CDC Certified DPP Master Coach, which was necessary to lead this programme in NZ. This research project received full ethical approval from the Health and Disability Ethics Committee *(see Appendix 1).*

4.1 Researcher Training

From March 2020 to February 2021, I participated in the Lifestyle Coach course, in order to lead the programme in NZ. Approximately 30 participants participated in this course, which included participants Palau and the Federated States of Micronesia (FSM), such as, Yap, Chuuk, Pohnpei, and Kosrae. The first 6 months of the course included a weight loss programme and the second 6 months was maintaining the weight loss. The coursework also included weekly zoom meetings over a 12-month period in 2020. As part of this training, I gained the required knowledge and skills to be a Lifestyle Coach in the following areas:

strategies to help participants learn new lifestyle skills; goal setting; maintain motivation; facilitate group discussions; run support groups; and to learn new strategies to help participants to overcome obstacles, particularly for the initial six-month weight-loss programme.

Apart from attending the weekly educational and health promotional zoom sessions, the course also included monitoring my own weight and tracking my physical activities on a daily basis. I would record the date in my fitness log, how many minutes of exercise I did every day, obtain a weekly total, and what type of physical activity I performed each day. At the end of the week, this data was sent to the PI-DPP for data analysis and monitoring purposes. I also kept a record of my daily food log, in which I had to record what time I ate, where, and what I ate and drank. It was also important to record who I was with when I had the meal. The quantity of what I ate and drank was also recorded and at the end of the week, this information was sent to the PI-DPP for analysis and monitoring. The weekly action plan was also an important aspect of the PI-DPP. Each week I set myself three goals and what I plan to do before the next session. It included the actions of what I planned to do to achieve the goals; where, when, and how long will I do it; challenges I might face; and ways to cope with these challenges. The following week I then reviewed my action plan and then tracked whether I had completed the tasks that I had set out to do. This personal experience gave me insight as to the expectations of the intended participants and the processes and degree of commitment required to take part, which is no easy feat.

The participants enter the programme for an initial three months where the focus is on losing 5-7% of their baseline body weight, which is an intensive drive to lose weight. They are also

expected to achieve 150 minutes of physical activity each week at a moderate pace or more by the end of the first three months. Moderate pace has been described by the DPP, when someone is doing physical activity where they can comfortably talk, but not sing. At the end of the first three months of intense body-weight loss, participants enter a second three month period focusing on weight-loss maintenance. This was a time to keep off the weight they had lost, work towards their weight loss goal if it hadn't been reached yet, or lose more weight if they wanted to, and to sustain the 150 minutes of physical activity a week.

4.2 The DPP and PI-DPP Programme

The DPP is a Lifestyle Change Program that helps to delay or prevent T2DM as described in the previous chapter. It is the result of a randomized, controlled clinical trial conducted at 27 study sites in the USA between 1996 to 2001. The trial enrolled over 3,200 participants from various ethnic background, including Pacific Islanders (123). People who took part in the study were randomly put into one of three groups: Lifestyle Change, Metformin, or placebo. People who joined the Lifestyle Change group got a lot of training and were told to lose 7% of their body weight, keep it off, and work out 150 minutes a week. In the first 24 weeks, the researchers met with each person alone at least 16 times. After that, they met every two months and called each one at least once in between visits. People who were put into the Metformin group were given normal advice about what to eat and how much to exercise. They took 850 mg of metformin twice a day. People who were randomly assigned to the placebo group, on the other hand, got a sugar pill twice a day and were given normal food and exercise tips. People who started the study and later got T2DM stayed in it and got extra

care from their own doctors, especially if their blood sugar wasn't under control. The DPP's Lifestyle Change programme was given to all participants after the programme finished.

The CDC changed the National DPP to fit the needs of Pacific Islanders, which is how it became the PI-DPP Lifestyle Change Programme. Tailoring is a process that needs trust and cooperation from all involved. It included coordination and participation of community stakeholders and trusted experts in related fields, translating all the resources for the Lifestyle Coaches in the main Pacific Island languages in the USA and building into the programme health beliefs and cultural approaches into implementation, planning, learning and training. The tailoring process involved focusing on culture, language, community consultations, and investing in partnerships and relationships with key stakeholders.

4.2.1 Researcher positionality

As Pacific peoples here in NZ have the highest rates of T2DM in comparison to other groups, there was a need to determine whether a culturally tailored approach maybe more effective in reducing the risk of T2DM. To date there is no culturally tailored diabetes prevention programme in NZ, hence adapting the PI-DPP may prove effective when specifically targeted to suit Pacific people and their contexts. The adapted PI-DPP will be implemented among my Tongan community in both South and West Auckland. In terms of researcher positionality, I am of Tongan and Niuean ancestry. After migrating from Tonga, my wife and I and our two daughters currently live in West Auckland and attend the Free Church of Tonga located in the suburb of Henderson. Family, church, community, and health and wellbeing are really important to us. I have a very strong connection to the Tongan community in West Auckland as I have also worked with other Tongan churches and various communities in the area. Also,

I had previously worked at The Fono, a primarily Pacific PHO (Primary Health Organisation) in West Auckland. The head office for the Free Church of Tonga in NZ is based at Favona in the suburb of Mangere, South Auckland. I also have strong connections to the Tongan community in South Auckland and over the years I have implemented a few community programmes at the church.

4.3 Methods 1: Adaption of the PI-DPP

Of particular note, to adapt or tailor an existing and well-established prevention programme relevant to the Pacific Island communities (i.e., PI-DPP), it was crucial to avoid taking away components in the programme that have proven be successful in past interventions involving Pacific Islanders. Researchers are advised that communities take into account the following kinds of planned prevention programme alterations and adaptations that prevent misaligning the programme and prevention activities required by the community (124).

4.3.1 Programme Adaptation Considerations

Before the adaption of the PI-DPP started, there were important aspects that I had to considered in tailoring an established and efficacious prevention programme. Firstly, the "*cultural adaptation"*. This referred to adjusting the intervention so that it aligned with the views, lifestyle, and especially the culture of that particular community. Secondly, the "*cognitive adaptation"*, which included considering whether altering the intervention's linguistics, reading level, or age range would be beneficial. Thirdly, "*affective-motivational adaptation"*, this is an important aspect in adapting a prevention programme where the participants' gender, ethnicity, religion, and socioeconomic background need to be considered for the success of the programme. "*Environmental adaptation"* is adjusting

aspects of the community's ecology, such as, considering whether the implementation of programme is environmentally friendly, such as, in the church hall, rather than a council facility. Another factor that needed to be considered was the "*adaptations of programme content"*. For example, this involved adapting the language, pictures, examples, scenarios, and activities utilized throughout the adapted prevention programme specifically to the targeted audience (i.e., tailoring and contextualizing the content from an American to a NZ context). Finally, "*adaptations of the programme form"* included tailoring the programme's structure and aims, both of which have the potential to impair the effectiveness of the programme. It was important to me as the lead researcher to ensure that the uniqueness and the primary structure of the programme was retained where possible and to avoid over-adapting and making major changes (124).

4.3.2 Citizens Panels

To adapt the PI-DPP, I employed the use of Citizens Panels, which is a participatory approach and it is based on the analogy of the jury system (125). The panels aimed to be a representative consultative body made of local community members. This approach is typically used to discuss, deliberate, and identify local priorities and to consult service users and non-users on specific issues. Citizens Panels are similar to the Pacific model called "*fa'afaletui"* (126) (127) (128) (129), which is a form of decision-making system, where the family first deliberate and reach consensus on an issue. Delegates from each family then meet, share their decision, and deliberate until achieving community consensus (130) (131). The agreement/s are then fed back to each family for validation (129). This cultural approach establishes greater trust within the family and can yield deeper insights of the issues, than focus groups. The fa'afaletui model facilitates the gathering and critical validation of Pacific

knowledge, and it is the critical process of weaving (tui) together all the different levels of knowledge-frames from within the "houses" (fale) of collective representation, in order that the Pacific view is substantially enhanced (132) (133). Researchers that have used this model have reported that families, elders, parents and young people who have gathered together to discuss and weave together their own experiences, memories and knowledge, as being beneficial and enhancing for themselves as participants, as much as, it has been beneficial to the research process of gathering data. Although this approach is a Samoan model, it was still relevant for use among the wider Pacific communities. Of note, Aitaoto has used this model with different Pacific Island groups, including Tongans, in adapting the DPP for Pacific Islanders.

To adapt the PI-DPP, I used the panels approach because it had been used successfully before in Aitaotos' work (personal communications, 2020) and in previous DPP adaptation among pan-Pacific Islanders in the USA (64). Of note, the DPP programme had been fully translated in Tongan and this removes the language barrier for older Tongan participants to take part in the project. This approach was employed to culturally adapt the PT2 curriculum (including the various health education sessions, and other resources aligned to improving healthier lifestyle changes). Of additional note, in consultation with the community, it was decided that all the Community Panels were to be carried out on zoom because of the restrictions and lock-down period that occurred in NZ and particularly in the Auckland region due to covid-19 (2020-2021).

4.3.2.1 Citizens Panel 1: Community members

The community panel members (n=15) were selected through my personal community networks from two Tongan communities, South (Site 1) and West Auckland (Site 2). The participants were chosen as being active contributors within their communities, age range (22 – 60 years). There was almost an equal mix of gender members (male = 7, female = 8), and the members represented different church denominations (e.g., Free Church of Tonga, Methodist, Seventh Day Adventist) and various work skills (e.g., construction workers, firefighter, corrections officer, church Reverend, restaurant manager, public health researcher, social worker, logistics and freight, and dental assistant). All the panel members have Tongan heritage and are active in their various communities and church. The average age overall for this panel was 42.5 years old (sd = 12.04) *(see Appendix 15)*.

Procedures

(i) The first Citizens Panel started with a prayer by our Cultural Advisor (church Reverend) as per Tongan cultural protocol. I then welcomed everyone before I carried out a short plenary presentation about T2DM in NZ that included information on the prevalence of prediabetes among Pacific peoples, T2DM and its effects on health, current landscape of T2DM prevention programmes in NZ, including community based interventions programmes, a description of the DPP, Prevent Type 2 (PT2) curriculum (used by the PI-DPP), and key learnings from the PI-DPP. The questions proposed in this panel were developed by the researcher, based on learnings from the DPP, PT2 curriculum, and from the PI-DPP. See *Appendix 15* for the question schedule.

(ii) The participants then broke out into three groups by way of being allocated into a zoom.us online platform, using the break-out rooms option, and discussed the questions based on the plenary session. These subgroups were sorted by age and gender for sensitivity and cultural reasons.

(iii) The plenary group re-convened and each sub-group relayed their findings to the questions to the whole group and provided recommendations for tailoring the program, and curriculum modules. The group consulted towards a general consensus on the adaptations, and identified any potential questions for the second panel to consider for their agreed adaptations.

4.3.2.2 Citizens Panel 2: Health expert representatives

This panel was selected from a wide range of health experts (n=10), mainly through my own and other professional networks (e.g., university and clinical recommendations). The panel included clinicians, general practioners, nurses, nutrition experts, district health board members, and academic public health researchers, who have experience in working with patients with T2DM, or research experience in long-term conditions. The make-up of the panel consisted of four males, six females, and the participant ages were similar across the gender groups, with a total average age of 49.1 years (sd = 8.73).

Procedures

(i) The health expert panel commenced with a prayer by the Cultural Advisor, followed by a short presentation about T2DM in NZ that included information on the prevalence of prediabetes among Pacific peoples, T2DM and its negative effects on the health of people, current prevention programmes in NZ and community-based interventions, a

description of the DPP, Prevent Type 2 (PT2) curriculum, key learnings from the PI-DPP, and the consensual decisions from the 1st Citizen's Panel *(see section 4.3.2.1).*

(ii) The participants were then divided into sub-groups (based on their roles as academics and researchers; doctors, nurses, nutrionists, and DHB (District Health Board) workers to discuss questions based on the plenary session and the recommendations and questions that were borne out from the first Citizen's Panel.

(iii) The plenary group re-convened and sub-groups summarised their findings on 'what' and 'how' to tailor the PI-DPP based on a clinical perspective and current practices in the NZ health system context. These recommendations were discussed and questions and topics for discussion were prepared for the third Citizens Panel.

4.3.2.3 Citizens Panel 3: Representatives from Citizen's Panel 1 and 2.

These representatives (n=10) were chosen on how active they were throughout the discussions and also based on their availability. The panel was made up of four males and six females, and the average age was 49.9 years old (sd = 9.17).

Procedures

(i) The third Citizen's Panel started with a prayer and then I presented the agreed decisions from the second Citizen's Panel.

(ii) Participants were divided into breakout groups via zoom and were asked to discuss the decisions from the second panel. The discussion decisions were consolidated into practical ways ensuring modifications were tailored to a NZ context, such as: the duration of the programme – to make it shorter; the educational modules to suit and relate to the NZ Tongan context; be more inclusive of a family approach rather than

just focussing on the individual with the condition; access to the programme overall; and to be able to talk and explain things in Tongan.

(iii) The plenary re-convened, and a collective finalisation of the overall curriculum for the community programme and implementation was affirmed. The adapated PI-DPP, now called the **"Sia Tō'onga Mo'ui Diabetes Prevention Programme" (STM-DPP)**. Resources were then prepared for use in Phase 2.

4.3.3 Definition of "Sia Tō'onga Mo'ui Diabetes Prevention Programme" (STM-DPP)

In Tonga, **Sia** has two meanings; 1) the process when traditional fishing nets are being woven; and 2) a height where you can be able to see more of the sea or land. **Tō'onga** means lifestyle, behaviour or actions; and **Mo'ui** means health or life. Hence, "**Sia Tō'onga Mo'ui**" means standing or being at a level where one can see clearly and be able to weave their lifestyle to a better health. The level is important, as it reminds us with where we come from, where we want to go, and how to get there, and it also aligns well with the Fa'afaletui model described earlier. The short form of the **"Sia Tō'onga Mo'ui Diabetes Prevention Programme" (STM-DPP)** which will be used throughout this thesis from here onwards .

4.3.4 Data Analysis and Findings of the adaptation of the PI-DPP

All citizens panels were audio recorded on zoom and transcribed verbatim, dates of data collection and all activities were documented. A thematic analysis of the qualitative data was carried out using the six steps developed by Braun and Clarke (2006). The steps were: (i) become familiar with the data; (ii) generate initial codes; (iii) search for themes; (iv) review themes; (v) define themes; and (vi) write-up. It should be noted that for the most part, the citizens panel discussion was carried out using the Tongan language as participants were more

comfortable and provided more clarity and understanding. I had conducted multiple reviews of the transcriptions to gain a comprehensive understanding of the data, while simultaneously recording notes. I had also translated this discussion into English by transcribing and interpreting the recordings from the conversations held during the Citizens Panel. The notes were annotated using short and simple language and organized into groups according to their content. As a result of this process, coding categories were selected and labeled. I had conducted a thorough review of the transcripts to identify and emphasize any texts that aligned with the various coding categories. The patterns and themes were noted during the process of classifying the texts into coding groups. The primary themes underwent a process of categorization and assessment to ascertain their accuracy in representing the data. This technique was iterated to validate, authenticate, and broaden topics, as well as to ascertain any presence of four major themes that formulate the adaptation of the PI-DPP, which are presented below.

4.3.4.1 Theme 1: Suitability of the PI-DPP to a Tongan-only, NZ context is possible.

The data obtained from this phase was subjected to a thematic analysis procedure, resulting in the identification of three sub-themes. *Table 3* presents the views of all citizens panels on whether it is possible to adapt the PI-DPP programme to be suitable to a Tongan-only community in Auckland, NZ. The general consensus is that they strongly believe that the PI-DPP can be adapted to suit the Tongan community in Auckland, based on three sub-themes came out.

Table 3. Suitability of the PI-DPP to a Tongan-only, NZ context is possible.

Citizens Panel #1 Community Members	**Citizens Panel #2** Health Professionals	**Citizens Panel #3** Mixture of Panel #1 & #2
"Can be done with sacrifice" "I think it can be done if I commit to it and want to be healthy, then I will sacrifice once a week, and weekly for 6 months"	"Well, I suspect that you could" "It has proven to work for other ethnic groups so I'm sure tweaking it to suit our Pacific communities here in New Zealand is possible"	"…while the PI-DPP was mainly for people in the US, there is no reason why this can be adapted to suit our Tongans here in Auckland"

(a) Adaptation and Cultural Relevance

Emphasizing the importance of tailoring programs and approaches to suit specific cultural contexts and communities, as evidenced by successful adaptations for different ethnic groups from the research presented. Fortunately, the PI-DPP had already been tailored for a US Tongan community, and when we reviewed its relevance for a NZ context, it was suitable for use for our local community.

> *"It has proven to work for other ethnic groups so I'm sure tweaking it to suit our Pacific communities here in New Zealand is possible" - (CP#2)*

(b) Potential for Expansion and Localization

Exploring the possibility of extending and adapting existing programs to new geographical locations and communities, this will not only showcase the potential for broader implementation and impact but provide evidence-based knowledge on how flexible the DPP is and could be adapted for use in other countries.

> *"…while the PI-DPP was mainly for people in the US, there is no reason why this can be adapted to suit our Tongans here in Auckland"*- (CP#3)

(c) Commitment and Sacrifice

This sub-theme highlights the necessity of dedication and willingness to make sacrifices for achieving goals, particularly in matters of health and wellbeing. Also, this sub-theme promotes the need for participant commitment to the programme and reflecting the motivation and desire to be healthy.

> *"I think it can be done if I commit to it and want to be healthy, then I will sacrifice once a week, and weekly for 6 months"*- (CP#1).

4.3.4.2 Theme 2: Adapting the PI-DPP Programme to be culturally appropriate for NZ-based Tongans.

Four sub-themes were highlighted from the citizens panels' discussions, primarily ensuring social, cultural and religious factors that needed to be included or modified. These included: (a) lifestyle and flexibility; (b) religious and cultural sensitivity; (c) continuous learning and adaption; and (d) delivery methods preferences for programme modules.

(a) Lifestyle and flexibility

This sub-theme emphasizes the need for the PI-DPP to be adapted to accommodate the diverse work schedules and commitments, including long hours and irregular shifts, of the Tongan people in NZ, to ensure accessibility and participation. More specifically, the adaptations to the PI-DPP were to include four areas of change:

i) **Duration:** Based on the various opinions and considerations surrounding the ideal length of the PI-DPP program, which is currently 12-months. It was decided that

the STM-DPP be piloted to a shortened duration of six months to balance and manage factors such as engagement, sustainability, and participant commitment.

> *"…6 months is a good length of time, taking into account we live a very busy life.*
>
> *I have been participating in a couple of intervention programme, the longest was 4 months".*
>
> *"I would do the programme if it's no more than 6 months"*
>
> *"Programme needs to be delivered no longer than 6 months"*
>
> *"6 months is the maximum length of time I think this prevention programme should go, for taking into account how busy Tongans here in Auckland are"*

ii) **Tailoring for effectiveness**: In line with (i) noted above, this factor highlights the need to adapt the program duration to suit the specific needs, preferences, and constraints of the Tongan community in Auckland, NZ, with a focus on maximizing effectiveness and to reduce the drop-out rate.

> *"…making the program shorter so that, because we know that the ability to commit the amount of time that they would need to commit is going to be a big barrier and we're already looking at dropouts, there's going to be a risk, a big problem that's likely to happen"*
>
> *"6 months is the maximum length of time I think this prevention programme should go, for taking into account how busy Tongans here in Auckland are"*
>
> *"…perhaps it can be delivered in a shorter period, more engaging for the audience that you're targeting…"*

iii) **Balancing engagement and time constraints:** Addressing the challenge of maintaining participant engagement while also considering the time constraints and busy lifestyles of the target demographic, this factor shows the importance of finding a balance between programme length and participant attention span.

> *"This thing has to be delivered in no more than about three or four months, uh, to, to keep the attention level there"*
>
> *"…perhaps it can be delivered in a shorter period, more engaging for the audience that you're targeting…"*

iv) **Practicality and simplification:** this factor was about streamlining the PI-DPP programme components, such as recording dietary intake and physical activity, to make them manageable and realistic for participants, particularly with consideration for busy lifestyles.

(b) Religious and cultural sensitivity

Adapting the PI-DPP to ensure a good fit with Tongan culture around religious beliefs, recognizes the central role religion and culture plays in the lives of community members, and ensuring alignment with their values and practices. his sub theme brought to light different sub-nuances: (i) holistic approach and family inclusion; and (ii) cultural and spiritual integration.

> *"the programme will be adapted to fit around our religious activities"*
>
> *"Our religion is the centre of our lives, and everything is based around it, the programme needs to adapt to those condition, what day and time the exercise and zoom sessions runs to ensure it does not interfere with other church programme and obligation"*

i) **Holistic approach and family Inclusion:** This nuance of the sub-theme advocates for the integration of cultural, familial, and spiritual elements into programme modules, recognizing their significance in the lives of Tongan individuals and communities, and emphasizing the importance of addressing the various aspects for holistic health promotion and education.

> *"Think about diabetes think about the whole family"*
>
> *"Needs to be a whanau approach/family approach"*
>
> *"One person doesn't make the change no matter how much they know – needs to be a family approach"*

ii) **Cultural and Spiritual Integration:** This nuance highlights the importance of incorporating cultural and spiritual aspects into programme modules, recognizing their significance in the lives of participants and enhancing the relevance and effectiveness of the prevention programme.

> *"…our traditions and culture is important and the hierarchy and Tongan tradition needs to be taken into account when adapting the programme"*
>
> *"…the programme needs to be adapted to suit the culture of the Tongan community living here in NZ so that it acknowledged and respects the way we live"*

(c) Continuous learning and adaptation:

Two sub-theme nuances were derived from this main theme, including the practical implementation, and addressing barriers to commitment. It acknowledges the importance of drawing on past experiences and lessons, both successes and failures to inform the

adaptation of health programmes for the Tongan community, ensuring continuous improvement and effectiveness in meeting their needs and preferences.

> *"…so the changes that will need to be made to suit a Tongan community, may be guided by the learnings that we got from the successes and failings of the previous ones…"*
>
> *"The learnings from the biggest looser programme may need to be looked at. Programme engaged a whole lot of people"*

i) **Practical implementation:** The first sub-theme emphasizes the importance of practical and achievable actions for participants to implement what they learn, focusing on simple and sustainable behaviors such as healthy eating and regular exercise, while also acknowledging potential barriers to program adherence, such as burdensome recording requirements.

> *"Recording what people eat and drink every meal, every day, for 6 months is unrealistic, especially as there is no incentive"*
>
> *"Putting into action what participants will learn in the zoom session is sufficient, and that is to eat healthy and exercise 30min or more every day is simple enough. To record everyday their physical activity, their minutes, what they eat every meal, for 6 months will be self-imposed barrier to staying in the programme for its duration"*

ii) **Addressing barriers to commitment:** This sub-them highlights the concerns about participant dropout rates and barriers to sustained engagement, such as time constraints, and the need to mitigate these risks by shortening the programme duration.

"Because we live in Auckland it's hard enough finding time"

"It feels like it's a burden too because you think of trying to have that time. But because of everything that's happening, you just don't, you know, you're unable to fit everything all at once"

"Hard to find time to commit to the programme"

"Food log maybe difficult for people"

"Difficult for people to commit for 12 months"

(d) Programme delivery method

All three panels were consistent in reporting the need for the programme to be delivered both an accessible online programme (zoom) and having a face-to-face option. The sense of community and the opportunity for live updates through interactive communication during the implementation phase aligns well with "talaloto", a socio-cultural and religious practice familiar to Tongan people and churches (134). Face-to-face sessions will also be an opportunity for support and sharing of experiences. The idea of a Facebook page was also considered appropriate to maintain communication with participants and shared experiences**.** Analyses from this main theme resulted in five subthemes nuances:

i) **Streamlining for efficiency:** Advocating for the adjustment and consolidation of program modules to shorten the duration of the prevention program, ensuring that it remains accessible and manageable for participants.

"Adjust and Consolidate the modules so that the prevention programme can be shorter"

"I look at the list, that list is actually good, you know, itself. I think it's the structure with where you can combine things and bring it closer to home."

"I think consolidating the program to be tailored to the population in a shorter timeframe is the trade off to not have this CDC accreditation, but it will be more effective if it's designed for your population and that, um, thinking about timing"

ii) Diabetes awareness and education: Highlighting the importance of educating the community about the risks associated with T2DM, particularly focusing on the impact of traditional Tongan starch foods and the need for dietary changes to prevent or manage the condition.

"Educate community beforehand before they become diabetic"

"It's actually to educate our people and to prevent the incidence of diabetes per se, whether that's anything to do with insurance or not"

"Everyone is busy and it's hard to find time for various programme, first thing is education, is to educate our people, that if we want to live longer than we need to try and lose weight, change the way we eat…"

"Need to educate our people how dangerous our Tongan starch food is for diabetes"
"…have a module that talks about Tongan starch foods"

iii) Blending Virtual and In-Person Engagement: Advocating for a mix of zoom and face-to-face interactions to accommodate participants' needs and maximize engagement, recognizing the importance of both formats for fostering community, accountability, and convenience.

"Both face to face and zoom"

"Important to check in with each other, which is why face to face is important as well"

"Meeting in person would be the most impactful because we can hold each other accountable, there's that sense of community, having people around, but also having zoom calls are more convenient sometimes"

iv) **Holistic health approach:** emphasizes the importance of incorporating healthy eating habits and physical activity into programme sessions, including providing healthy food options and making time for exercise, while also addressing the cultural contexts and practical challenges, like finding time for working on healthy behaviors.

"Promotional material and everything need to be in Tongan"

"Make time for exercise but don't try and find time"

v) **Community and Supportive Environment:** Prioritizing the creation of a supportive and inclusive programme environment where participants can openly discuss their challenges and successes, share experiences, and provide encouragement to one another, fostering a sense of belonging and accountability within the group.

"Be more interactive rather preaching…"

"Deliver the programme in a way that is fun, sexy, and also be able to empower, encourage, and support participants right through the programme"

"Last 15min of each session to be given to participants to talk about what works and don't work for them during the week so others can learn from, encourage each other to keep going, talk about what's in their hearts, similar to that of the Tongan word "talaloto".

4.3.4.3 Theme 3: Motivating participation

This theme strongly relates to theme two and tailoring the programme to the Tongan community, and the ideas noted by the panels describe the different ways of how the programme can incentivize the participants to be retained in the project.

i) **Competition as motivation:** Encouraging participants by framing the programme as a competition can foster engagement and commitment.

"Run the programme as a competition."

ii) **Cultural Incentives:** Incorporating cultural elements or incentives that resonate with the community's values and traditions can enhance participation and motivation.

"Cultural incentive"

"….do something that accommodates their lifestyle, that's probably the biggest thing for me is that for us who works eight hours a day, we go at night, come home at 5am. There is a lot of people who works 8 hours a day but there are those that work 12 hours a day just to make ends meet. Is there something in the program that would be tailored for their lifestyle?"

iii) **Physical Activity Support:** Providing resources such as equipment, facilities, and other platforms to support physical activity, especially during challenging seasons, can incentivize participation and adherence to the program.

"…does your programme provide a cycling machine or anything that you are offering us that will participate in your programme?"

"If we don't have time to exercise, get out of the house and weed the garden, do the vacuum, stay home, and keep moving if you can't go and get involved in other exercise programme"

iv) **Incentives in community programmes:** Recognizing that incentives are common in community programmes and understanding their effectiveness, particularly in encouraging sustained engagement.

"Most community programmes have some form of incentives, the longer the programme the better the incentives were"

"Incentive to motivate people to remain in the programme"

v) **Nutritional Incentives:** Offering food as an incentive during sessions, especially at the face-to-face meetings, can serve as a motivating factor for participation and attendance.

"Make sure you have some food in every session…that's why it has to be face to face, that'd be an incentive"

"Make sure there's healthy food at the face-to-face sessions"

4.3.4.4 Theme 4: Factors that can enhance commitment to programme participation

This theme identifies the factors that contribute to the participants' commitment to programme. Understandably, people lead busy lives and therefore place priorities on other commitments. However, the panel recognized that, participant commitment to the programme will be key to success, individually and for the overall programme. The following illustrate some sub-themes nuances:

i) **Commitment as Key to Success**: The quotes emphasize the crucial role of commitment in achieving success in the program. Whether it is sacrificing time, maintaining honesty, or prioritizing health despite fatigue, and commitment is portrayed as essential for achieving desired outcomes.

"I usually spend 2 hours in the gym, but I will commit if I want to live longer to watch my children and grandchildren grow, and If I value that than I will make the commitment to the programme"

"But true if I don't commit to the programme then you will not succeed, by the time I get home I feel tired. But if I don't have the commitment, I should go, even though I'm tired, I'll have to go there"

"I think it can be done if one commits to it and wants to be healthy, then I will sacrifice once a week, and weekly for the first 6 months"

ii) **Personal Values and Motivation**: Personal values and motivations often drives commitment. Should the participants express a desire to be healthy and to witness important life events like seeing their children and grandchildren grow, then this kind of intrinsic motivation and personal values should be fostered into to the programme.

> *"…those that value their health will participate"*
>
> *"…yes and participants commitment will depend really on how much value they put on their health, and their family"*

iii) **Realistic goals and achievability**: The panel recommended that the programme is based on setting realistic goals and recognizing the achievability of the programme's requirements. By acknowledging that exercising for 30 minutes a day and attending educational sessions are achievable tasks, participants are more likely to commit to the programme. This point also emphasizes the need for practicality and feasibility in the programme to facilitate participant commitment:

> *"…exercising for 30min a day and attending a 1 hour educational zoom session is achievable"*
>
> *"Honesty is required if I want to be healthy, and also logging and recording what I did during the week, if you set some goals I'm sure you can achieve it"*

4.3.5 Adaptation and modification of the PI-DPP

Following the citizens panel discussions, the main adaptations of the PI-DPP for use in a NZ context as informed by the thematic analyses from the citizens panel are as follows, to:

- shortened the programme duration from 12 months to six months;
- adjust and consolidate some of the modules to relate to the NZ Tongan culture, spiritual wellbeing, and the NZ lifestyle;
- modify the programme to be more family-oriented, which is the anga faka-Tonga way of being and doing;
- implement the programme to fit around church and family activities;
- identify some form of incentive to encourage participation and retention for the newly proposed duration of the programme;
- ensure the lifestyle coach/researcher can speak and write in Tongan fluently, know the culture, the food, the hierarchy and status of the Tongan people. This capacity and capability links back to understanding the Tongan culture and history, so that he has a good working knowledge of the participating community.

The STM-DPP programme aims to address T2DM among the Tongan community in Auckland. It emphasizes the importance of respecting Tongan traditions and culture, and adapting to the community's lifestyle and religious activities. The programme's duration should be no more than 6 months, so as to maintain continuing interest and to ensure that participants can feasibly complete the programme in its entirety. The modules will focus on reducing starchy food intake, promoting weight-loss, and incorporating Tongan cultural aspects. It will be

delivered through face-to-face communication and regular online zoom meetings promoting normalization and respect for the participants and their families. The approach will emphasize regular physical activity, household routines, and education on lifestyle changes for longevity and weight loss. The incentives will be provided to encourage participation and commitment to the program which will be crucial for long-term health.

4.3.6 Adaption of resources

4.3.6.1 Enrolment Questionnaire

In the current study, the PI-DPP enrolment questionnaire was used, however it was adapted to suit the NZ context. The PI-DPP enrolment questionnaire was selected as a basis for the STM-DPP enrolment as this was already tested and implemented. However, I removed the questions around health insurance and who is paying for their participation in the programme from the STM-DPP enrolment as it had no relevance to participants here in NZ, or to the objective of the study. The STM-DPP enrolment questionnaire (participants demographic information sheet – *see Appendix 5*) was pre-tested on five Tongans in our church to get an understanding on how long it took to complete the form, and each had reported that the questionnaire was time appropriate and easy to complete .

4.362 Prediabetes Risk Test (PDRT)

The Prediabetes Risks Tests (PDRT) is a standard procedure of the DPP and the PI-DPP. It is a one-page questionnaire that assesses one risk of pre-diabetes. The original PDRT used the US imperial measurements, and this was adapted to the standard metric measurements so it can be relevant to the NZ context and the current study *(see Appendix 6)*. The PDRT was used to

identify participants at risk of prediabetes as a precursor for T2DM, and as a proxy resource for community-based participants. It was also considered a less invasive alternative to collecting blood samples for blood glucose levels and it was cost efficient.

There were certain variables in the PDRT that could not be changed, such as age of participants, gender, whether women had ever been diagnosed with gestational diabetes; and whether participants had ever been diagnosed with high blood pressure. The PDRT score is based on a total maximum of 11 points. In order to reverse prediabetes and prevent or delay type 2 diabetes, participants would be required to lose a significant amount of weight. If participants received a score of five or more then the PDRT classifies you as being an increased risk for having prediabetes, and at high risk of T2DM.

4.4 Methods 2: Implementation of the STM-DPP

4.4.1 Participant recruitment

The parcticipants were selected from two Tongan communities located in the South and West of Auckland city. Over 41.0% of all Tongans in NZ live in South Auckland and 11% live in West Auckland. To be eligible to participate in this study all of the following criteria had to be met. This criteria was taken from the National Diabetes Prevention Programme, where CDC-recognized lifestyle change programs are designed for patients who have prediabetes and are at high risk for developing T2DM:

- 18 years and older (<75);
- be overweight/obese BMI > 24) (135);
- have NOT been diagnosed with type 1 or type 2 diabetes;

- not be pregnant; and
- *self-reported* recent blood test *(within the last 12 months)* in the prediabetes range that includes one of the following: non-fasting HbA1c blood test (based on NZ guidelines): NZ classification is 41 – 49 (5.7 to 6.4%); or a Fasting plasma glucose: 100–125 mg/dL; or a Two-hour plasma glucose (after a 75 gm glucose load): 140–199 mg/dL**;** OR have received a result of high risk for T2DM on the Prediabetes Risk Test scores.

For this study, the accepted HbA1c levels and the classification are shown in *Figure 1.* Normal diagnosis is 40 mmol/mol or less, and those who have between 41 – 49 mmol/mol were considered as prediabetic and those who has 50 mmol/mol or more were diagnosed as having T2DM.

Figure 1. HbA1c Level and corresponding diagnosis

Diagnosis	HbA1c level
Normal	40 mmol/mol or below
Prediabetes	41–49 mmol/mol
Diabetes	50 mmol/mol or above

Source: https://www.healthnavigator.org.nz/health-a-z/h/hba1c-testing/

(a) Recruitment

Convenience sampling was used to identify participants for this study. Convenience sampling was defined as a method where research data are being collected from a conveniently available pool of partificipants. It is the most commonly used sampling technique in qualitative and exploratory research because it is time efficient, low cost, less complicated, participants are readily approachable, and for quick data collection (2). For the current study,

convenience sampling was used because part of the approach to adapting the PI-DPP was to ensure that a Tongan community perspective was included, and this also helped to build confidence and knowledge about the programme among community members. It should be noted that convenience sampling inferences needs to be treated with caution, because the results cannot be generalized to the target population because of potential bias due to under- or over- representation of subgroups in the sample in comparison to the population of interest.

For this project, I have recruited 41 participants from two Tongan communities in West (Massey) and South (Favona, Mangere) of Auckland city, using promotional flyers *(see Appendix 11)*, social connections through health provider networks, and through my community/church networks. The adapted programme started on Wednesday 16th June, 2021 in West Auckland, and Thursday 17th June 2021 in South Auckland.

(b) STM-DPP Implementation

Implementing the STM-DPP was adapted for a duration of six months and involved two stages. Stage 1 included collecting the baseline data and three months of intensive weight-loss through the adapted modular training of the programme. Stage 2 was dedicated to weight loss maintenance which also has a duration of three months. In comparison, the DPP is a 12 month programme where the first six months is the intense weight loss stage and the last six months is the maintenance stage. On the other hand, the PILI Lifestyle Programme (PLP) is a nine months prevention programme, where the first three months is the adapted weight loss intervention programme, and the last six months provided lessons in weight loss maintenance (136). A major goal for each participant in the STM-DPP was to do 30 minutes of moderate

exercise or physical activity each day; attend the educational and health promotion zoom sessions each week; and to achieve a weight-loss target of 5% or more of their total body weight.

4.4.2 Stage 1: Baseline Data Collection

Baseline data from the participants using a questionnaire *(see Appendix 5)* was carried out one week prior to the start of the STM-DPP. The following information was gathered:

(i) Social demographics (ie: age, ethnicity, NZ v Island born);

(ii) Family history of T2DM. Lifestyle factors including physical activity frequency, smoking history, and a dietary diversity questionnaire of the last seven days as an assessment of dietary patterns;

(iii) Past medical history with particular reference to diagnosis of any other CVD disorders (eg. IHD), mental health conditions, respiratory and other inflammatory diseases;

(iv) Current medications (eg. weight inducing medications). Questions used were taken from previously validated questionnaires (3).

(v) Clinical markers data**:**

(a) Blood pressure – measured on the right arm with the participants sitting upright at rest for at least 5 minutes;

(b) Anthropometric measurements: body weight (kg), height (cm), were measured from which BMI was calculated;

(c) Self-reported HbA1c recorded results of a non-fasting blood sample were collected from the participant, as per inclusion critiera;

(d) Physical functioning based on the 6MWT (6 Minute Walk Test) provided baseline information on physical functioning capacity (4);

(e) Prediabetes Risk Test *(from the PI-DPP, see Appendix 2)*

(vi) Diet Diversity

The diet diversity questionnaire requires the participants to record what they ate over a seven day period (five weekdays and two weekend days). The survey has 13 food groups with varying number of food items:

Group 1: (27 food items: Meat, Poultry and Fish diversity)

Group 2: (18 food items: Dairy Products diversity)

Group 3: (32 food items: Bread, Cereals and Starchy Vegetable diversity)

Group 4: (9 food items: Legume and Nut diversity)

Group 5: (30 food items: Fruit diversity)

Group 6: (37 food items: Vegetable diversity)

Group 7: (9 food items: Oil and fat diversity)

Group 8: (15 food items: Drinks diversity)

Group 9: (8 food items: Alcohol diversity)

Group 10: (22 food items: Sauces, Spreads and Flavouring diversity)

Group 11: (12 food items: Sweets and Sweet Snacks diversity)

Group 12: (10 food items: Savoury Snacks diversity)

Group 13: (14 food items: Take Away Food diversity)

4.4.2.1 Stage 1:

(a)Intensive weight-loss

This part of the initial stage involved a high intensive weight-loss programme for three months, characterised by moderate exercise of 30 minutes or more per day, attend weekly meetings and sessions of one to three hours facilitated by myself, using an online platform (zoom). The first three months included a total of 18 modules (described below). A number of the modules were consolidated and delivered in one session *(see Appendix 9 for STM-DPP schedule).* In addition to the participants doing their own exercises, two 60 minute aerobics sessions were also being run during the week at the Free Church of Tonga church hall. These exercise sessions offered were not part of the original STM-DPP but they were added to the prevention programme to encourage participants out in South Auckland (Site 1) to exercise as a group. The participants from West Auckland (Site 2) had the option of attending the community exercise sessions run each evening in different parts of West Auckland, and the participants were asked to record their weekly food intake and physical activity log.

(b) Description of the adapted modules for the STM-DPP (Modules 1 – 18)

The **first module** formulated an introduction to the STM-DPP providing a programm overview; goals; explanation of the course; and my role as a lifestyle coach. This included reinforcing the goals for the participants to be committed to daily exercise for 30 minutes (or more) per day as a process to lose up to 5% or more of body weight; attend the weekly zoom meetings. **Module two** educates the participants about being active, making time to be active, overcoming challenges and setting action plans. **Module three** involved learning about the core principles of tracking activities; how to fill the physical activity forms; overcoming challenges; and developing an action plan for success. **Module four** focussed on eating well

and provided the core principles of healthy eating to prevent T2DM. It included making a healthy meal, making an action plan for healthy eating, identifying the items in each food group, as well as overcoming some of the challenges that prevents healthy eating.

Module five focussed on tracking food intake. It develops the participants ability to identify the purpose of tracking their food, learn how to track their food consumption, and explains how to use the nutrition facts labels on food items. **Module six** was focussed on Tongan starchy foods, and what to do at Tongan feasts and cultural functions. The module educated the participants about which Tongan starch foods are much more healthier to eat, and how much to consume per meal in relation to calories. The participants were encouraged to eat sensibly at Tongan functions and to find ways to remind themselves about their commitment to joining the STM-DPP. **Module seven** explored calorie expenditure and replacement. The participants learnt about the relationship between calories and weight gain and loss. **Module eight** was about the concept of getting more active to prevent T2DM. This module taught the participants about the purpose of getting more active, how to increase their activity level, and to be able to track more details of their fitness. **Module nine** was a session on managing stress to prevent T2DM. The participants were able to learn about the causes of stress and the link between stress and T2DM, identify ways to reduce stress, and healthy ways to overcome and cope with it. Finding time for fitness is presented in **Module ten**, and invariably it is difficult to do 150 minutes of activity each week so this module taught the participants how to find time for fitness. It teaches them how to identify some of the benefits of being active, and recognize and overcome the challenge of finding time for fitness. **Module eleven** focussed on coping with triggers to prevent T2DM. The participants were exposed to how to identify unhealthy food shopping habits and eating, food triggers, and ways to cope with

them. **Module twelve** educated the participants about heart health. Those who are at risk for T2DM were also at risk for developing heart problems. This module explained why heart health matters, how to keep a healthy heart, and to learn about the impact on the heart. **Module thirteen** examined shopping and cooking skills to prevent T2DM. The participants learnt how to shop for healthy foods and how to cook a healthy meal.

Module fourteen which was based on identifying and getting support from other people to help them to live a healthy lifestyle. There was also a focus on how to enlist support from family, friends, and co-workers. They also learnt how to get support from various groups, classes, and clubs, and also professionals. **Module fifthteen** focussed on participants learning how to take charge of their thoughts to help prevent or delay T2DM. In this module, the participants learned how to recognize the difference between harmful and helpful thoughts, and how to replace harmful thoughts with helpful thoughts. **Module sixteen** provided strategies to participants when eating well away from home. They also learned how to how to maintain their dietary goals at various cultural and social events, including restaurants. Identification of challenges and coping strategies to manage these challenges. **Module seventeen** focussed on encouraging the participants how to stay motivated to stay in the programme and to achieve their goals. The participants learn to reflect on their progress and to keep making positive changes over the next three months. **Module eighteen** was about how to take action when weight loss stalls. This module taught the participants why weight loss can stall and how to kick-start losing weight again.

4.4.3 Stage 2: Intensive Stage

(a) Weight loss maintenance stage

After the initial intensive weight loss stage, the second stage revolved around weight loss maintenance, which consisted of two meetings per month of 1 – 2 hours per meeting to complete the STM-DPP programme for three months *(see Appendix 9 for STM-DPP schedule)*. These sessions occurred via zoom due to the covid-19 lockdown, and it would run over the scheduled allocated time as participants wanted to talk about their journey and how they are doing in regards to the programme, including the covid-19 impact on themselves and their families. The participants were still required to do 30 minutes or more of moderate exercise a day during this period, and included the following adapted modules:

(b) Description of the modules 19-23

Module nineteen taught the participants how to stay active. They learnt how to identify some benefits of staying active, as well as identifying some challenges of staying active and finding ways to overcome those challenges, and to reflect on how far they have come since joining the programme. **Module twenty** provided the participants with a deeper understanding of T2DM, how to prevent and manage it, particularly if they go onto to develop the condition. **Module twenty-one** was a session where participants learnt about the benefits of taking a fitness break (e.g., a 2-minute fitness break every 30 minutes). The module taught the participants how to recognize the link between sitting still and T2DM. **Module twenty-two** was about how important it is to get enough sleep and its role in health. This module also provided the participants with strategies on how to cope with some challenges of getting enough sleep. Finally, **module twenty-three** was about preventing T2DM for life. It encouraged the participants to keep their healthy lifestyle going, and to continue with self-

reflection on their progress since they started the STM-DPP, and to encourage them to keep making positive changes long-term.

(b) Post- STM-DPP Data Collection.

At the completion of the STM-DPP (i.e., 6 months from baseline), the following data was collected after the last module was delivered *(see Appendix 9 for STM-DPP schedule**)*** to examine lifestyle changes that occurred from baseline. This data was collected one week after the STM-DPP ended, as that would have been the best way I would have been able to collect the data and to avoid loss-to-follow-up.

The data collected after the implementaton of the STM-DPP was:

- Clinical Markers

  (a) Blood pressure

  (b) Anthropometric measurements:

  - Weight
  - Waist

  (d) 6MWT

- Dietary diversity

4.4.4 Data Management and Analysis

The data for both pre- and post- STM-DPP were then documented, coded, and entered twice into separate Excel spreadsheets. Checks for errors was made before the data was exported into statistical software programmes SAS (Statistical Analysis Software, version 9.4) and R (R Core Team, 2020) (137) for analysis to obtain descriptive statistics to identify participant

changes of relevant characteristics and clinical markers. Frequencies and percentages were used to describe proportions of the study sample and means, and standard deviations (sd) were used to describe specific characteristics.

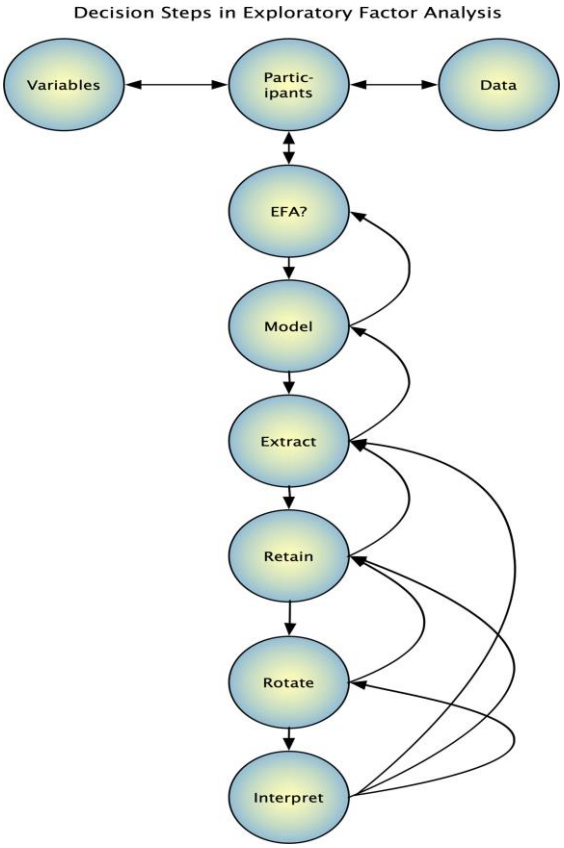
4.4.5 Diet Diversity Analysis

The statistical software programme R was used to analyse the diet diversity data. The dietary diversity questionnaire was compiled to assess the diversity of individual food and food groups in Pacific peoples' diets (138). Exploratory factor analyses (EFA) were used to examine summary patterns that describe the types of diet for the Tongan community groups in South and West Auckland. There were thirteen variables, each variable measuring the proportion of food items each participant ate for that particular food group. The measured variables (described in Section 5.1) are thought to correlate with each other due to the underlying latent constructs, the so-called factors. With EFA it is expected that unique factors explain some variance (diversity) about the diets beyond that it is explained by common factors.

Steps in Exploratory Factor Analysis (EFA)

With EFA, *Figure 2* shows the flow chart of the exploratory nature of EFA and the knowledge that the evidence for some decisions was uncertain or dependent upon prior results.

Figure 2. Steps in Exploratory Factor Analysis (EFA)



Source: A step by step guide to Exploratory Factor analysis (Watkins M. A step-by-step guide to exploratory factor analysis with Stata. Routledge; 2021 Sep 8)

I had used these steps to make decisions and particularly where some steps contained several complex components. *Figure 3* was used as a checklist in conducting the EFA, which ensured consistent implication of evidence-based, best practice decisions (139).

Figure 3. Decision Steps in EFA

Source: A step by step guide to Exploratory Factor analysis (Watkins M. A step-by-step guide to exploratory factor analysis with Stata. Routledge; 2021 Sep 8)

4.5 Methods 3: Evaluation of the STM-DPP

4.5.1 Focus Groups

At one month following the completion of the STM-DPP, the evaluation phase was undertaken whilst participants still had their experiences of the STM-DPP fresh in their minds. The evaluation involved two focus groups for those who:

(a) completed the STM-DPP

(b) did not complete the STM-DPP

The aim of the focus groups were to examine the uptake and identification of the:

(a) successful STM processes for engaging the people in the programme;

(b) benefits and practical applications of the STM-DPP; and

(c) behavioural, cultural, and motivational drivers of change, as perceived by the participants.

Both focus groups were being conducted via the zoom online platform, due to the ongoing covid restrictions at the time, especially in Auckland, NZ. It was audio-recorded, transcribed verbatim, and the dates of data collection and all activities documented. The participants in each focus group were selected due to their contribution and how active they were in the STM-DPP, and their availability. Each focus group started with a prayer by our Cultural Advisor, who is a church Reverend, as per Tongan cultural protocol. I then welcomed everyone before I carried on conducting the focus group.

4.5.2 Data Management and Analysis

To analyse the focus group data, I used the principles of Talanoa which was originally designed to be centred on Tongan values, beliefs, and practice, and to capture the rich knowledge of participant experiences. Moreover, the practice of Talanoa (as opposed to semi-structured interviews) was a better fit for this project because it is more familiar to how Pacific people related and consulted with each other (15). The talanoa has been defined as an open, informal conversation between people in which they discuss, share their stories, thoughts and feelings (18) (140) (141). Analyses using deductive reasoning approaches was used to identify key themes in accordance with the six phases of thematic analysis to achieve saturation of themes, as described by Braun and Clarke (2006) (142).

CHAPTER 5: RESULTS

Chapter 5 discusses the results focusing on the two key components or phases of this research: i) Implementation of the STM-DPP and ii) Evaluation of the STM-DPP. The purpose of the results was to see whether the STM-DPP is feasible and acceptable programme to be used in a Tongan, NZ context:

1) implement the lifestyle change STM-DPP using a community-based approach lose 5% or more of body weight of Tongans living here in Auckland;
2) to examine the uptake and identification of successful STM-DPP processes for engaging the people in the programme;
3) the benefits and practical applications of the STM-DPP; and
4) obtain a review of the behavioral, cultural, and motivational drivers of change, as perceived by the participants.

5.1 Phase 2 – Implementation of the STM-DPP

Phase 2 involved implementing the STM-DPP starting with baseline data from the participants were collected which included their demographics and household characteristics, clinical markers, and their diet for the last seven days. Post-STM-DPP data were also collected to examine the success of the adapted programme.

5.1.1 Response Rates

Table 4 shows the characteristics of participants including some descriptive results of selected health indicators. Of the 53 participants recruited for the STM-DPP, 41 participants completed the programme, with 27 of the participants from the South Auckland study site, and 14 from the West Auckland site.

5.1.2 Participant demographics

All of the participants self-identified as being Tongan, and males accounted for 61.0% of the total participants, and the remaining 39% were female. *Table 4* showed that a total of 41 participants participated in the entirety of the duration of the STM-DPP. The average age of participants were 44.4 years old (range = 22 – 68 years) with an average age of males being three years older, compared to females. Participants who were married made up 85.4% (n = 35) of the total study sample. The majority of the participants had some form of education, with 26.8% of the total participants obtained high school level education (they were mostly male). However, females (29.3%) had attained higher level qualifications (i.e., formally recognized qualifications), compared to males (17.1%). A large proportion of the study sample were employed (90.2%) , and the perceived health status of the participants indicated that 36.6% rated their health status as being “good”, with 26.8% saying their health status was “fair”, and 21.9% of the participants reported as having “poor” health status. The participants who were diagnosed with an existing health condition, including high blood pressure (17.1%), and 73.2% as having family history of diabetes.

Table 4. Participant demographics (Frequencies and Percentages)

Characteristics	Male n (%)	Female n (%)	Total
Total Recruitment			n = 53
Completed the STM-DPP			n = 41
Gender	25 (61.0%)	16 (39.0%)	n = 41
Age, mean (SD)	45.52 (11.06)	42.63 (11.07)	44.39 (11.02)
Site			
South Auckland	17 (41.5%)	10 (24.4%)	27 (65.9%)
West Auckland	8 (19.5%)	6 (14.6%)	14 (34.1%)
Marital Status			
Married	21 (51.2%)	14 (34.1%)	35 (85.4%)
Single, Never Married	4 (9.7%)	2 (4.9%)	6 (14.6%)
Education			
Primary/Intermediate School	3 (7.3%)	0	3 (7.3%)
High School	10 (24.4%)	2 (4.9%)	12 (29.3%)
Diploma/Trade Certificate/Degree/Masters/PhD	7 (17.1%)	12 (29.3%)	19 (46.3%)
Other	5 (12.2%)	2 (4.9%)	7 (17.1%)
Employment status			
Unemployed	2 (4.9%)	0	2 (4.9%)
Employed	22 (53.7%)	15 (36.6%)	37 (90.2%)
Retired/Pension	1 (2.4%)	1 (2.4%)	2 (4.9%)
Perceived Health Status			
Poor	6 (14.6%)	3 (7.3%)	9 (21.9%)
Fair	7 (17.1%)	4 (9.7%)	11 (26.8%)
Good	7 (17.1%)	8 (19.5%)	15 (36.6%)
Very Good	4 (9.8%)	1 (2.4%)	5 (12.2%)
Excellent	1 (2.4%)	0	1 (2.4%)
Diagnosed Health Conditions			
High Blood Pressure	4 (9.8%)	3 (7.3%)	7 (17.1%)
Stroke	1 (2.4%)	0	1 (2.4 %)
Cardiovascular disease	1 (2.4%)	0	1 (2.4%)
Lung	0	0	0
Arthritis	2 (4.9%)	1 (2.4%)	3 (7.3%)
Depression and/or Anxiety	0	0	0
Others	3 (7.3%)	2 (4.9%)	5 (12.2%)
None	14 (34.1%)	9 (22.0%)	23 (56.1%)
Family History of Diabetes			
Yes	18 (43.9%)	12 (29.3%)	30 (73.2%)
No	7 (17.1%)	4 (9.7%)	11 (26.8%)
On current medication	7 (17.1%)	8 (19.5%)	15 (36.6%)

5.1.3 Baseline data collection pre-STM-DPP

The baseline data collection provided information on participants characteristics relating to clinical markers.

5.1.3.1 Descriptive results of baseline clinical markers

Table 5 below describes the frequency distribution of participant characteristics at baseline.

Table 5. Descriptive results of baseline clinical markers for participants (frequencies and percentages)

Characteristics	**Male**	**Female**	**Total**
	n=25	n=16	N=41
Gender	61.00%	39.00%	
Weight (kg)	118.94 (16.95)	119.59 (23.42)	119.19 (19.45)
BMI (kg/m^2)	38.5 (5.5)	42.8 (7.8)	40.2 (6.8)
Categorized BMI			
Underweight	0	0	0
Normal Weight	0	1 (2.4%)	1 (2.4%)
Overweight	1 (2.4%)	0	1 (2.4%)
Obesity	24 (58.5%)	15 (36.6%)	39 (95.2%)
Height (cm)	175.78 (5.71)	166.89 (5.15)	172.31 (6.98)
Waist (cm)	117.16 (13.93)	120.25 (18.57)	118.37 (15.75)
Waist to Height Ratio	0.67 (0.08)	0.72 (0.1)	0.69 (0.10)
Healthy Waist (0.4 – 0.49)	0	1 (2.4)	1 (2.4)
Increased Health Risk (0.5 – 0.59)	4 (9.7)	1 (2.4)	5 (12.1))
Highest Risk (=>0.6)	21 (51.2)	14 (34.1)	35 (85.3)
Self-Reported Average blood glucose levels (missing n = 5)	43.5 (3.7) n=21	42.97 (4.2) n=15	43.2 (3.8) N=36
Low (Systolic < 90 mmHg)	0	0	0
Normal (≥ 90 mmHg ≤ 130 mmHg)	3 (7.3%)	2 (4.9%)	5 (12.2%)
High (Systolic > 130 mmHg)	22 (53.7%)	14 (34.1%)	36 (87.8%)
Systolic pressure	151.4 (18.3)	155.1 (31.6)	152.8 (24.0)
Diastolic pressure	89.0 (9.6)	93.9 (15.4)	91.0 (12.3)
Pulse pressure	73.4 (9.8)	86.7 (10.2)	78.6 (11.8)
Six Minute Walk Test (m)	484.5 (119.6)	467.4 (83.0)	478.2 (106.0)
Predicted (mean, stdev)	582.6 (69.1)	498.7 (78.0)	549.9 (82.8)
Above lower limit	15 (60%)	16 (100%)	31 (75.6%)
Prediabetes Risk Test Score	5.9 (1.3)	5.0 (1.1)	5.6 (1.3)
Risk (PDRT ≥ 5)	21 (51.2%)	10 (24.4%)	31 (75.6%)
No Risk (PDRT < 5)	4 (9.8%)	6 (14.6%)	10 (24.4%)

(a) Weight

A very high proportion of the participants were obese (95.2%) - males represented 58.5% (n = 24) and females accounted for 34.1% (n = 14). Out of the 41 participants, only one (a female) recorded a normal weight, and 39 of the 40 participants were defined as being obese. The average BMI was 40.2kg/m^2 (6.8%) with females reporting a higher BMI average of 42.8kg/m^2 (sd = 7.8), while males were 38.5 kg/m^2 (sd = 5.5). The average weight for participants were 119.19kg. The average height was 172.3cm and waist measurements was 118.3cm.

(b) Waist to Height Ratio (WHtR)

Females' waist circumference on average was 120.2cm, which was much higher than those among males (117.1cm). The mean WHtR ratio was 0.69 (sd = 0.09), where females had an average WHtR ratio of 0.72cm (sd = 0.10) compared to lower average for males at 0.67cm (sd = 0.08). The WHtR ratio reported 85.1% (n = 35) which is indicative of a very high health risk, and this is an indicator of central obesity and increased risk of CVD. The participants who had WHtR ratios of 0.5 to 0.59 accounted for 12.1%, which indicated that they have increased health risks.

(c) 6 Minute Walk Test

The six minute walk test reported an average of 478.2m (sd = 106.0), with males being able to walk an average of 484.5m (sd = 119.6) in the six minute timeframe, compared to females who had an average of (467.4m (sd = 83.0).

(d) Blood Pressure

The vast majority of the participants (88%) had recorded elevated blood pressure levels (systolic pressure above 130mm Hg), with a higher proportion (53%) of males in the group having high blood pressure readings, compared to females (34%). High blood pressure is also a major risk factor for T2DM.

5.1.3.2 Diet Diversity

Information relating to the participants Diet Diversity were collected at baseline illustrating the foods and food groups consumed over a week-long period. The diet diversity has 13 groups of food ranging from meats, dairy products, bread, legumes, fruits, vegetables, oil and fats, drinks, alcohol, sauces, sweets, savories, and takeaways.

(a) Diet Diversity Survey

Group 1: (27 food items: Meat, Poultry and Fish diversity)

Group 2: (18 food items: Dairy Products diversity)

Group 3: (32 food items: Bread, Cereals and Starchy Vegetable diversity)

Group 4: (9 food items: Legume and Nut diversity)

Group 5: (30 food items: Fruit diversity)

Group 6: (37 food items: Vegetable diversity)

Group 7: (9 food items: Oil and fat diversity)

Group 8: (15 food items: Drinks diversity)

Group 9: (8 food items: Alcohol diversity)

Group 10: (22 food items: Sauces, Spreads and Flavoring diversity)

Group 11: (12 food items: Sweets and Sweet Snacks diversity)

Group 12: (10 food items: Savory Snacks diversity)

Group 13: (14 food items: Take Away Food diversity)

(b) Analysis and Summary statistics for food groups

By definition, the summary statistics sum up the features of a data sample. They describe the values and provide related measurements. These work as a basis for understanding the values recorded during a study. Descriptive statistics shows where the mean of a set of values lies. The key part for EFA in this study was to transform the raw diet diversity data into 13 new variables containing the proportion of times a person answered "Yes" in each diet group. This proportion will act as the response variable. EFA analyzed 13 response variables, for each variable representing a proportion of a positive answer in the diet group.

The summary statistics in *Table 4* above shows that for all food groups the skew < 1.0 or kurtosis < 1.0 indicates univariate normality (143). These univariate statistics indicate that all food groups were relatively normally distributed, which means that there should not be much concern about correlations being restricted due to variable distributions. The skew (departures from symmetry) and kurtosis (distributions with heavier or lighter tails and higher or flatter peaks) of all the food groups appear to be close to normal (normal distributions have expected values of zero).

Table 4. Summary statistics for 13 food groups

vars	n	mean	sd	median	min	max	range	skew	kurtosis	se
G1	41	0.54	0.17	0.54	0.15	0.92	0.77	-0.05	-0.14	0.03
G2	41	0.39	0.2	0.44	0.00	0.76	0.76	-0.07	-0.81	0.03
G3	41	0.53	0.2	0.53	0.06	0.94	0.87	-0.05	-0.56	0.03
G4	41	0.37	0.2	0.38	0.00	0.88	0.88	0.51	-0.34	0.03
G5	41	0.48	0.27	0.41	0.00	0.97	0.97	0.21	-1.24	0.04
G6	41	0.5	0.23	0.51	0.06	0.89	0.84	-0.09	-1.13	0.04
G7	41	0.58	0.23	0.56	0.11	1.00	0.89	-0.06	-0.84	0.04
G8	41	0.52	0.23	0.5	0.00	1.00	1.00	0.19	-0.55	0.04
G9	41	0.29	0.34	0.25	0.00	1.00	1.00	0.73	-0.94	0.05
G10	41	0.50	0.24	0.48	0.10	1.00	0.90	0.49	-0.58	0.04
G11	41	0.59	0.29	0.58	0.00	1.00	1.00	-0.35	-1.01	0.04
G12	41	0.51	0.31	0.5	0.00	1.00	1.00	-0.05	-1.26	0.05
G13	41	0.59	0.31	0.64	0.00	1.00	1.00	-0.52	-0.97	0.05

(i) Testing for Linearity

Pearson's Correlation between pairs of Food Groups was conducted and this table is in *Appendix 13 (a)*. In general, if the Pearson correlation coefficient (r) is between –1 and 1 that measures the strength and direction of the relationship between two variables. When one variable changes, the other variable changes in the same direction. Although, the Pearson correlation for these analyses showed a strong positive relation between food groups. It is important to note that the high correlation does not imply dependence (or causation).

(ii) Testing for multivariate normality

Testing multivariate normality of the 13 food groups can be done in two different ways. EFA is a suitable analysis only when the data "passes" the assumption of multivariate normality. The skewness is similar to the expected skewness in a multivariate normal. The data passed the Mardia test for skewness. Refer to *Appendix 13 (b)* for data.

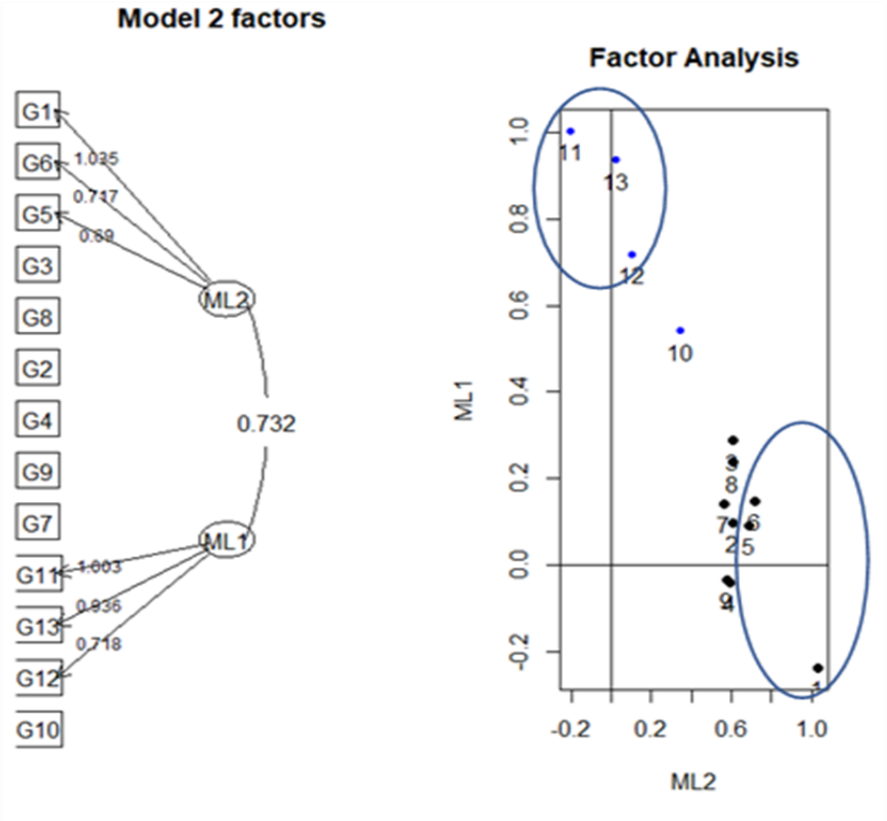
(iii) Testing for multicollinearity

EFA is doubtful if there is multicollinearity among variables (one or more variables are simply multiples of others). The determinant of the correlation matrix must be larger than 0. This holds for our correlation matrix thus, there is no multicollinearity. Although the determinant is close to zero, it is not identically zero. Refer to *Appendix 13 (c)* for data.

(c) Model Selection

Using the EFA Model Selection *(see Figure 3)*, a summary of the model selection process was made. The left-hand plot shows the variables (Diet Groups) within each factor having a Norman and Streiner's value of importance larger than 0.628. The arrows connecting factors and variables are labelled by the standardized loadings. The correlation between the two factors is 0.732. The plot at the right shows each variable in the factor space. The rightmost variables on the plot, G1, G5 and G6 have the highest standardized loadings for the factor ML2 on the horizontal axis. The uppermost variables on the plot, G11, G12, G13 have the highest standardized loadings for the factor ML1 on the vertical axis. I have encircled those variables in the plot.

Figure 4. EFA Model Selection



In summary, I can conclude that the participants ate mainly two food groups over a seven-day period. The first factor includes foods from meat, poultry and fish, fruits, and vegetables. The second factor was classified as Junk Foods, included foods from sweets and sweet snacks, savory, and take away foods.

Factor 1 = "Meat, fruits and vegetables".

Group 1: (27 food items: Meat, Poultry and Fish)

Group 5: (30 food items: Fruit)

Group 6: (37 food items: Vegetables)

Factor 2 = “Junk Food”

Group 11: (12 food items: Sweets and Sweet Snacks)

Group 12: (10 food items: Savory Snacks)

Group 13: (14 food items: Take Away Food)

5.1.4 Post STM-DPP intervention data results

After six months of the implementation of the STM-DPP, post intervention data was collected at one week after the intervention had ended. This was to explore whether the STM-DPP had made any impact on the clinical markers. Tests for significance was based on paired-T-Tests. *Table 5* compares the baseline and post-intervention data.

Table 5. Comparing baseline and post-intervention data

Clinical Marker	Group	Baseline	Post-intervention	P-value, one-tailed t-test	Type of test
Weight (kg)	All participants	119.2 (19.4)	113.8 (18.3)	< 0.0001	
	Male	118.9 (16.9)	111.8 (13.7)	< 0.0001	L
	Female	119.6 (23.4)	116.8 (24.0)	0.0380	
Waist (cm)	All participants	118.4 (15.8)	114.7 (14.5)	< 0.0001	
	Male	117.2 (13.9)	112.7 (12.5)	< 0.0001	L
	Female	120.2 (18.6)	117.7 (17.1)	0.0690	
Waist to Height Ratio (WHtR)	All participants	0.69 (0.10)	0.67 (0.09)	< 0.0001	
	Male	0.67 (0.08)	0.64 (0.07)	< 0.0001	L
	Female	0.72 (0.11)	0.71 (0.10)	0.064	
6-Minute Walk Test (m)	All participants	478.2 (105.9)	576.2 (97.8)	< 0.0001	
	Male	484.5 (119.6)	611.2 (88.1)	< 0.0001	U
	Female	468.4 (83.0)	521.6 (88.8)	0.025	
	Predicted	549.9 (82.8)	582.6 (69.1)	< 0.000	
	Above lower limit	31 (75.6%)	39 (95.1%)		
Systolic Pressure (mmHg)	All participants	152.8 (24.0)	147.7 (24.1)	< 0.0001	
	Male	151.4 (18.3)	144.4 (17.6)	< 0.0001	L
	Female	155.1 (31.6)	153.0 (31.8)	0.110	
Diastolic Pressure (mmHg)	All participants	90.9 (12.3)	90.7 (11.8)	0.425	
	Male	89.0 (9.6)	88.0 (10.4)	0.256	L
	Female	93.9 (15.4)	95.0 (12.9)	0.690	

Note: P-values were computed using Lower-Tailed (L) or Upper-Tailed (U) Matched-Pairs t-tests with n=41 participants (25 males and 16 females).

(a) Weight

After six months of the STM-DPP, overall, all participants lost on average 5.4kg (4.5%), with males losing an average of 7.1kg (6.0%) while females lost an average of 2.8kg (2.3%) *(see Table 5)*. All corresponding p-values $p < 0.05$ meant that the changes in weight were significant between baseline and post-prevention. Twenty-four participants lost 5% or more in body weight while 12 participants lost more than 7% of body weight *(see Table 6)*. Note that those who lost 0 – 4.9% of body weight and those that gained 1 – 5%, had the lowest attendance rate for the education sessions and also some of these participants did not complete the programme.

Table 6. Percentage lost or gained in body weight

Percentage lost or gained	Number of participants	Percentage completed (41)
Lost 0 – 4.9%	6	14.6%
Lost 5% or more	24	58.5%
Lost between 5 – 7%	12	29.3%
Lost more than 7%	12	29.3%
Gained 1 – 5%	4	9.7%

(b) Waist to Height Ratio (WHtR)

On average, participants lost an average of 3.7cm ($p < 0.05$) for waist post-prevention. By gender, males lost an average of 4.5cm ($p < 0.05$), with female losing an average of 2.5cm, however this loss in waist circumference was not significant with a borderline p-value of 0.069.

(c) 6 Minute Walk Test

Participants have increased their average meters in the 6 Minute Walk Test from baseline of 478.2m (sd=105.9) to 576.2m (sd=97.8) post-prevention, which is an increase of an average

of 98m. The number of meters on average for males increased significantly by 126.7m ($p < 0.05$) from a baseline average of 484.5m. Females also increased their average meters in the 6 Minute Walk Test from baseline of 468.4m (sd = 83.0) to 521.6m (sd = 88.8), an average increase of 53.2m, which was found to be significant ($p = 0.25$). The predicted meters in relation to participants gender, age, weight and height were 549.9m (sd=82.8) at baseline and 582.6m (sd= 69.1) at post intervention. At baseline, 31 (75.6%) participants were above the lower limit, however after the intervention 39 (95.1%) were found to be above the lower limit.

Table 7 shows the percentage difference between baseline and post- STM-DPP was 17.7%. The prevention programme provided a mean of 17.7% improvement in the walking test, and this was statistically significant with a p-value<0.0001. A moderately positive association is indicated by a Pearson correlation coefficient of 0.5. In general, a moderate correlation is defined as one with a correlation coefficient between 0.4 and 0.7.

Table 7. T-tests: Paired two sample means

Baseline		**Post**	
Mean (sd)	0.88 (0.19)	Mean (sd)	1.03 (0.15)
t = -5.99, 41 df, P < 0.0001			

(d) Blood Pressure

Despite the decrease in systolic blood pressure, blood pressure for all participants in general were still high. Caution should be exercised in reporting a lowered blood pressure at the end of the programme. Some contributing factors that participants had when measuring their blood pressure included anxiety of not knowing what to expect from the programme; caffeine

consumption; performing resistance and cardiovascular exercises. There was no change in the diastolic blood pressure at the end of the prevention programme.

5.1.5 Summary

In summary, after six months of the STM-DPP, the clinical markers point to the right direction with sustaining weight-loss (58.5% of participants losing 5% or more in body weight) and the increase in physical activity capacity as measured by the 6 minute walk test. The blood pressure appears to remain very high at baseline and at post- STM-DPP prevention. Despite 17% of participants indicating they have high blood pressure, there is a possibility that many of the participants not knowingly had high blood pressure and needed to be seen immediately by their family doctor. These participants were notified about their test results and I had requested that they visit their GP for further assessment and treatment.

5.2 Phase 3 – Evaluation of the STM-DPP

In Phase 3, the uptake and acceptability of the programme was explored, including identifying the enablers and barriers of the programme in reducing the progression of prediabetes to T2DM in Tongan adults, aged 18-74 years old. Two focus groups were conducted.

1) Participants that completed the STM-DPP
2) Participants that did not complete the STM-DPP

These focus groups examined the uptake and identification of:

1) successful processes for engaging the participant
2) benefits and practical applications of the STM-DPP

3) review behavioural, cultural, and motivational drivers of change, perceived as the un/successes of the programme

5.2.1 Focus Group Data

The data presented in this section includes those views expressed by the participants from the focus group that completed the STM-DPP, and those that could no longer participate in the study.

Overall, the participants in the focus group who completed the programme reported that they enjoyed the STM-DPP programme and thought that the programme and its contents was very good; helpful and useful; inspirational, especially during the covid lockdown; and it was freely available to them. The zoom sessions were informative and helpful. A feature of the programme reported was that the STM-DPP programme encouraged participants to exercise and provided education around lifestyle changes, provided support and strategies to overcome challenges. Therefore, five major themes were identified from across the focus group talanoa.

5.2.1.1 Completed the STM-DPP

Theme 1: Positive Structure and Effectiveness and of the STM-DPP

This theme highlights the general consensus from the participants of the STM-DPP relating to the positive structure, particularly in how the module components provided structure for the participants to achieve their goals. The structured approach was also progressive, where there was enough knowledge and information to take on and apply without having to make big non-realistic changes. Some participants' observations are noted in the following table:

Table 8. Positive Structure

"The constant reminders every week of the key messages and outcome of the programme."
"I really enjoyed the programme and all its content, especially during the very hard Lockdown."
"Participating in this programme has been very good for me, it kept me on track with the contents and information the programme offered."

In addition, the effectiveness of the STM-DPP was also described through the nuance that it provided transformational changes to people's lifestyle and behaviors. Understandably, the programme is based on the well-known effective DPP initiative, and having this awareness also provided participant confidence in the programme, encouraged behavioral and mindset change – the latter being the biggest impact of the STM-DPP. Furthermore, the name of the programme, *Sia* is to weave like the weaving fishing nets, and *Too'onga* is behavior, and *Mo'ui* is lifestyle. The participants comments captured this thematic nuance:

Table 9. Effectiveness

"This programme has woken me up and has reminded me where I come from, and how diabetes has destroyed my close family."
"Joining this programme it has changed me, and I know for sure that I will continue with this lifestyle change."
"Part of the programme that I like is building relationships, it helped change the way I eat, my lifestyle, improved my behaviour, including my sleep."
"For me, the meaning is changing your old way of life with newer and better lifestyle."

Theme 2: Constructive approach of the programme

The participants addressed the positive aspects of the programme which mainly included factors that were characteristic of anga faka-Tonga which was culturally appropriate. Family involvement in participating and supporting individual members not only removed barriers, but it also highlighted the enablers of the programme such as, inclusivity, accessibility, holistic motivation (because the whole family were included), education and the overall benefits of health and wellbeing that were indirectly affected because of the programme approach. Some expressions from the participants describe this:

Table 10. Constructive approach

Family Support and Participation: *"I joined to support my 3 daughters, so the best part was actually losing the weight and it has really helped me change my lifestyle for the better."* *"What I enjoyed best was about the programme was being able to do it as a family. With my dad and 2 sisters, where trying to change my dad's eating had always been the hardest (mainly because he didn't want too). With joining with him, changing what was being bought and not having to cook more then what we were all eating made it easier."* **Accessibility and Inclusivity:** *"It was open to all age groups and not just for those at borderline diabetes."* **Motivation and Education:** *"I like the programme because it motivates me, my weakness is the food and the zoom sessions helped and educated me in what to eat."* *"The best thing about the programme is when I get on the scale and notice that I'm losing weight."* **Health Benefits and Well-being:** *"I'm 55 but I feel 21 now, I have lost the pain in my legs due to a healthier lifestyle, more exercise, less volume of food consumed, and to top it off I save money on food."* *"The best thing about the programme is when I get on the scale and notice that I'm losing weight. I use to run 3 or 4km on the treadmill but now I can run 7km."*

Theme 3: Educational modules and online interactions

The online interactions and presentation of the modules played a major role in the STM-DPP, particularly as the Auckland region in NZ were under covid restrictions. The modules were also a source of knowledge, and the interactions were important to retain participants and achieve a sense of cohesion for the communities participating across two different sites. For the most part, participants engaged with the online platform and the sessions provided participants with practical things to carry out until the next online meeting. The timing allocated for the interactions were appropriate too (weekly and then fortnightly). Some of the barriers to participation online included: time, shiftwork, and the covid-19 lockdown also had an impact on people's interest to engage in the programme fully, but these did not appear to have had a major impact on the overall results of the programme. Some phrases from the participants provide examples of this theme:

Table 11. Educational modules and online interactions

Positive Feedback and Learning Experience: *"I liked it! Short and sweet! I have learnt a lot from it!"* *"I really enjoyed the zoom sessions and the information that was presented. I found it very helpful!"* *"It really helped to hear other people's challenges and achievements over the weeks."* *"I found it very helpful! It also played a part in motivation during weeks where I did not feel as motivated."* **Challenges and Commitments:** *"Unfortunately, I was unable to join all sessions due to family/work commitments, but I thoroughly enjoyed it."* **Informative Zoom Meetings and Tools for Progress:** *"Information shared in our zoom meetings were great tools we needed throughout our journey."* *"Every week we had things to take out and challenges for the week until the next zoom meeting."* *"It was good that zoom meetings were weekly in the beginning and went fortnightly near the end."*

Theme 4: Motivators/Enablers of the STM-DPP

In addition to the positive aspects and effectiveness of the programme, the STM-DPP highlighted key enablers, such as, "group-based activities". One member said, "… that the programme allowed them to continue with the programme, 'Group work – helps to motive each other." Additionally, it was also noted that as the researcher, I had created a safe and caring space, where all were respected, and cultural protocols followed. The encouragement and support from the researcher and fellow participants enabled participants to remain in the programme.

A common motivator to participate in the programme was the existence of a family history of T2DM and that the programme provided an opportunity to 'break the family history'. One participant said that *"close members of her family have been impacted by T2DM and if she doesn't change then she will become a victim too",* and another said, *"Seeing a lot of my family members diagnosed with diabetes and some of them having passed away"* is a motivator to participate in the STM-DPP programme. Being a "role model" was a key motivator for some, with one relaying that he "wanted to be a role model and hope that his wife will "get off the couch" and do some exercise". For the majority of the participants, people wanted to be healthy; feel good; and feel happy.

Theme 5: Successful processes of the STM-DPP

Successful processes used by the researcher was primarily based on the researcher's capacity to "directly engage" with the participants, also having a "medical professional available" provided confidence to the participants. The programme also offered "flexibility", in that, when the covid-lockdown occurred, the programme continued with back-up plans and the

processes continued. Some of the corresponding challenges included, logging on to zoom, completing the food and exercise logs which required extra effort for the participants. This is not a new challenge and there are always ways to overcome these practical hurdles, particularly when participants can prioritize their efforts towards bettering their health. Furthermore, the "simplification" of the DPP and PI-DPP materials was a successful process of the adaptation, although some of the participants did highlight that further simplification of the programme can enhance the STM-DPP processes such as the use of a photo-App instead of logging all exercises and food, as the current form of logging all food and exercises was deemed impractical.

Another successful process of the STM-DPP was the "implementation of the practical strategies and the programme drivers" (the Lifestyle Coach and the modules) heightened the awareness of the programme and set-up expectations for participants, with the long-term view of mitigating health risks and improving healthy lifestyles.

5.2.1.2 Focus group of participants that did not complete the STM-DPP

Theme 1: Clarity of the STM-DPP

This theme refers to the clarity and transparency of the STM-DPP. Despite not completing the STM-DPP, participants feedback was that with well-defined objectives and content, the programme was open and honest from the start. The participants were able to make great strides towards their objectives with the aid of the resources and tools provided.

Table 12. Clarity of the STM-DPP

"The programme was very clear and transparent from the outset."
"The content and goals were clear."
"It was clear from the start of the program what we needed to achieve, and the tools shared with us definitely helped us along our journey."

The clarity of the STM-DPP also reflected positive feedback on the programme structure and its effectiveness. Following the first three months, a change of behaviour had already formed, and despite not being able to achieve their desired level of completion, one of the participants could see the importance of the remaining three months in sustaining the weight reduction and reinforcing the change in lifestyle. The participants also felt that the STM-DPP programme was very beneficial for the Tongan population and served as an effective measure in preventing diabetes.

"After the first 3 months, habit already created and although I couldn't finish like I wanted to, I can certainly see why the last 3 months were needed to maintain the weight loss and solidify the lifestyle change."
"The STM-DPP programme I think is a very good programme for our Tongan people and the prevention of diabetes."

As mentioned previously, one of the major issues was the impact of external factors on the prevention programme, mainly covid-19. It had affected the planning, delivery, and implementation phase of the prevention, including the continuation of participation of participants. Many participants found covid-19 and the uncertainty of lockdown was a disruption to their exercise sessions in the church and community halls, which contributed to them losing motivation to carry on with the study.

"The August lockdown did not help with the flow of the programme from my end as everything just stopped and defaulted to what was comfortable and easy to access."

Theme 2: Positive aspects of the programme

This theme stressed the positive aspects of the programme where participants felt that it was very supportive. The participants found the programme to be accepting and non-judgemental, and that the supportiveness of everyone in the group was enjoyable. The program's most enjoyable aspect was the supporting and uplifting atmosphere fostered by fellow church members and it's leaders. There was a sense of community engagement from participant in saying that that was the first programme made available to where their whole family was able to participate. The STM-DPP provided two exercise sessions in the church hall each week when there was no lockdown, however others who did not complete the programme attended few sessions. One of the online platforms for sharing and learning included a group Facebook page, which was closed to members only, and this allowed participants to share the healthy meals they were preparing and cooking, including their exercise sessions especially during the lockdown period.

Table 13. Positive aspects of the STM-DPP

Supportive Atmosphere:
"I really enjoyed how non-judgemental it was and how supportive everyone was within the group."

"The supportive nature and even better from fellow church members was what I enjoyed best about this programme."

"Everybody is supportive of each other."

Community Engagement:
"I liked that for the first time we had a program available to us at church where we could join as a family."

Exercise Sessions:
"Exercise sessions but only attend 2 sessions."

Online Platforms for Sharing and Learning:
"The group Facebook where people put on what healthy meals they were cooking."

Theme 3: Barriers to the STM-DPP

The barriers for participants to completing the prevention programme varied with some participants saying that "time constraints" was an issue for them. Some participants do work long hours, usually factory work and they struggled to participate in the prevention programme when they worked twelve hours a day. Therefore, "work" and "type of employment" was a barrier to some not being unable to attend the sessions. Other participants mentioned that their shift-work hours did not allow them to fully participate in the programme when one month they work night shift and then the following month they are on day shift making it impossible to consistently participate. "Time availability" was also a challenge due to the demands of having a young family along with other responsibilities that come with having a family – their needs were a priority, not addressing the T2DM risk. Due to the irregular work schedules, there are occasions when days off do not align with the scheduled sessions and exercises offered in the programme. One participant said he was unable to finish the prevention programme due to the "nature of his work". He was a truck driver and he had certain number of hours that he needed to drive and rest.

The "lack of group exercise" in the West site was a barrier for some of the participants. Group exercise was a crucial component for our Tonga people, "ngaue fakataha" or working together, and being surrounded by familiar individuals also served as a source of inspiration.

In the West Auckland group, there was a lack of group exercise sessions that were available in South Auckland's church hall. As a result, those in West Auckland lost motivation and enthusiasm to continue with the programme. While The West Fono organised the weekly community aerobics classes (which participants were urged to join via the STM-DPP), the experience was the same as compared to a group of familiar people participating in a prevention programme to achieve a common goal.

Table 14. Barriers to the STM-DPP

Time Constraints:
"Don't have time for the sessions due to my job type."

"Time - with a young family and children pressing for me to engage with them and their learning it was difficult to manage this and other commitments."

"Exercise - trying to fit in exercise after work. Had to switch it where I'd walk early I the morning as I'd be so tired and drained after work."

Work Commitment, Schedule, and Nature:
"Because I do shift work, sometimes time off work falls on the days and time that sessions and exercises are not on."

"Due to the nature of my work, I wasn't able to complete the programme."

"Work commitment prevented me from participating fully in the programme."

Health Conditions:
"GOUT - this condition prevented me to participate fully in exercise and attending sessions."

Lack of Group Exercise Opportunities:
"Group exercise is a key element, also having familiar people around motivates us but in the West Auckland group we didn't have the group exercise that South Auckland did in their church hall, hence we lose motivation."

"Although the Fono runs the community aerobics sessions that we had been encouraged by the programme to participate in but it's never the same."

Theme 4: Challenges of the STM-DPP

One major theme that participants reflected on was the challenges of the study procedures. For example, they found it difficult to consistently log their food and exercise and expressed the need for a simpler and more convenient method of logging data, such as an App that allows quick photo logging of meals and physical activities. The current food logging system was deemed too difficult and demanding, requiring participants to record every item consumed over a prolonged period, which was impractical for many. The process of logging food and exercise was perceived as time-consuming and challenging, especially for individuals with busy schedules and family responsibilities.

Table 15. Challenges of the STM-DPP

"Logging of food and exercise - I often forgot to do this but it is my personal responsibility. Maybe an app where we can quickly just take picture of every meal and log in our exercise".
"The food log was too difficult to do as you need to record anything you eat and drink during the day and keep that going for 6 months!"
"Doing the activity goal plan, food and exercise log is time consuming and don't have time to do that with a large family, demanding children and busy work schedule to have any time left to do it".

Overall, these were relevant barriers and challenges reported by the participants that could not complete the STM-DPP, and it provides important insights for how the STM-DPP could be improved in future related studies.

CHAPTER 6: DISCUSSION

The purpose of this chapter is to discuss the key findings relating to implementation and evaluation of the STM-DPP. In the methods chapter the resultant adaptation of the PI-DPP was presented and therefore it won't be discussed in detail here. However, this chapter will primarily focus on the interpretation of the key findings from phases 2 and 3, I may refer to phase 1 to explain any key differences, as necessary and appropriate.

In discussing the results and implications of the STM-DPP, I have divided this chapter into three main sections. The first section examines the potential biases and limitations of the study, providing a context for the discussion of the results. The second section examines the key findings of the study which are related back to the objectives. Finally, directions for future research are presented that are designed to contribute positively to the health and wellbeing of Tongan people and their community, and provision of health services and policy.

6.1 Potential Errors and Limitations of the Study

This section identifies the potential sources of errors in this study, discussing how they were minimized, and how they affected the interpretation of the results. Researchers are ethically obligated to clearly define the limitations of their studies and acknowledge potential sources of bias. By doing so, health professionals and policymakers will be able to assess, analyse study results, and take them into account when implementing them in practice or policy. Other general limitations of the study will also be discussed.

6.1.1 Bias

Bias is defined as any systematic error in a study that results in an incorrect estimate of the association between symptoms, and the risk of having the disease (144) (145). Moreover, bias have various impacts on the validity and reliability of the findings , which also undermines the accuracy of the conclusions and interpretation of the research findings (146) (147). Systematic errors can occur at any time during the study. Therefore, identifying the origins of bias and understanding how they affect the final outcomes are crucial components in drawing accurate findings. There are three categories of errors; selection bias, information bias and confounding (148), which will be discussed briefly in context to this study.

6.1.1.1 Selection bias

Selection bias is a systematic error that originates from the procedures and methods used to select participants, and from factors that may influence study participation (146) (148) (149). Selection bias occurs when the association between exposure and disease differs between individuals who participate in a study and those who would be eligible but choose not to participate (150).

Selection bias maybe inherent in this current study as the prevention programme has been examined in a sample population that is not fully representative, which may result in overstated overall effect sizes and/or incorrect conclusions. The sampling frame used to recruit participants includes:

- Convenience sampling, church and personal contacts
- Tongans in South and West Auckland

The sample selected is not representative of the general Tongan population at regional or national level for several reasons that explain this limitation: (1) the sampling frame did not allow for participants to be randomly selected, and therefore the results may be deemed to be biased by the fact that participants were volunteers and selected as a convenient sample; and (2) non-participating participants may also be inherently different to the study sample. Due to this procedure of selecting participants as a convenient sample, selection bias is a direct result of this procedure.

Considering the identified potential for selection bias, the STM-DPP achieved a reasonably high participation rate (77%), and this can be explained by the convenience sampling where I had access to community members. There was a total of 12 of participants who were not in the sample analyzed for the following reasons: time constraints; work commitment, schedule, and nature of work; health condition; lack of group exercises; and dietary challenges. Due to the small study sample, it was not possible to compare respondents and non-respondents on demographic variables such as sex and age. It was therefore impossible to assess the likely effect of selection bias.

The healthy workers effect (HWE) is a special form of selection bias (151), a common problem in study design similar to the current study. It arises when the sample is not representative of the general population. The general population will comprise of individuals with varying degrees of health, including those that have T2DM. The sample chosen will only include those that were eligible. This could have contributed to the high participation rate because those who wanted to participate in the programme had to meet certain criteria compared to those

who were not in the programme and may have systematically different characteristics. The lack of information and the small sample size made it impossible to estimate this bias. Another way to assess HWE would be to have a comparison group with similar risk factors. Findings from the implementation work carried out in the US Pacific region would fit these criteria because of the similarity of Pacific peoples being included in the programme and they are using mostly analogous study procedures. However, the findings of that work are currently not yet available (personal communications, Nia Aitaoto, 2024), and we will carry out comparisons when the USA sites are completed.

According to Sedgwick (2015) (152), the volunteers would be expected to differ from the population in their sociodemographic, behavior, attitudes, and health. It has been reported that, in general, those who participate in studies are more educated, come from a higher social class, and are more sociable than those who do not participate. Let us focus on behavior and attitudes. The table of participant characteristics show a better “mood” (Characteristic: Confidence to success in six months) from men than women. Indirectly, men seem to be more motivated to participate and "to fight" for the final goal of the study than women, who aim to achieve welfare through the improvement of their health conditions. Therefore, sex was likely a source of bias.

A number of respondents were excluded from the sample analyses, because they did not: complete the question, missing ethnicity or sex data, or their specified age was outside the age range (e.g., 104 years) and were difficult to be contacted. The exclusion of participants for analyses has the potential to introduce further selection bias, however this is unlikely as the number of participants excluded was relatively small.

In terms of the study feasibility, it was important to obtain endorsement from the leaders of the church and community to carry out the study as a pilot for pragmatic reasons (i.e., to investigate whether the programme was feasible in a NZ context), but also due to the covid restriction period. I was unable to extend the study time period and number of participants due to: financial and resource limitations, and also the engagement duration of community prevention programmes here in NZ.

6.1.1.2 Information Bias

Information bias is defined as the systematic difference in the way data on exposure or outcome was obtained from the study sample (144). Information bias, sometimes referred to as misclassification is a prevalent type of bias that significantly impacts the accuracy and reliability of research study (146). It stems from the methodology used to acquire or validate research measurements. These measures may be acquired by testing, or through observation, such as questionnaires or surveys.

There are several types of information bias, however the most relevant bias to discuss in the current study is collection, recall, and recording of information. To minimize the effect of information bias in this study, a couple of factors were implemented: (1) having a systematic procedure for collecting, quantifying and analysing data was employed; and (2) use of standardised questionnaire and accurately calibrated tools to guarantee consistency in the gathering of data. The tools used were also validated (e.g., PDRT). The systematic procedure included taking measurements twice and entered twice into the database. Checks were then applied to the data for quality control.

6.1.1.3 Confounding Bias

Confounding is thought of as a mixing or confusion of effects (153). It is a systematic error that researchers can prevent or remove from the study using restriction, matching, statistical control and/or randomization (149). Three characteristics are necessary for a variable to be considered a potential confounder: (1) it must be associated with the disease, meaning it should be a risk factor for the disease; (2) it must be associated with the exposure, meaning it should be unequally distributed between the groups that were exposed and those that were not; and (3) it cannot be an effect of the exposure or, in connection with this, be a factor in the disease's causal pathway (154).

In the current study, gender, age, and level of education are likely to be confounding variables. Various methods were used to control confounding (144). In this study, one of the ways to control confounding was 'restricting' by only including those participants who satisfied the eligibility criteria. For example, the study allowed only participants 18 – 75 years of age and who are Tongan. It was therefore impossible to correct for other potential confounders in the analyses, and it was difficult to assess the likely size effect of selection bias and participation bias.

6.1.2 Random error

Random error is defined as the residual error that remains after systematic error has been eliminated. It is nothing more than a deviation from the true population value that cannot be readily explained (149). Random error can be classified more exactly as a sampling error, which is a source of random error (148). Sampling error is described as arising from limited sample sizes, and it is highly likely that the current study was subject to random error because

of its small sample size, and therefore the results may be due to chance or hidden biases. It is impossible to sample an entire population in a study, and the smaller the sample size the larger the sampling error. Reducing random errors involves increasing the sample size which can result in improved precision of estimates. There are, at least, two other sources of random error; biological variation and measurement (or instrument) error.

The *biological variation* is when participants have uncontrolled biological differences that may explain differences in the response to the STM-DPP. This may occur when a participant is prone to be immune to any prevention programme and, on the other hand, another participant is able to respond successfully to the prevention programme, and this difference is only explained by differences in their biological constitution. If we extend this idea of biological variation to include psychological/attitudinal variation, there will be another source of random error (typical of studies where sampling units are free-will human beings). This biological variation is also called "participant or subject variability". Participants variability might be one explanation for the presence of extreme values. An analogy due to biological variation, participants might respond to intervention like very tall basketball players or like very short people; however, the table of participant characteristics is useful to detect (initially) the existence of outliers but, after intervention and due to biological variation, there is no guarantee that outliers are nonexistent.

After systematic error is removed, there may exist a residual error when measurements are made, known as *measurement error*. In other words, measurement error is the variance between a measured quantity and its true value. There are four main sources of measurement error; the mode of data collection; the interviewee/participant (respondent),

the interviewer/researcher (measurer), and the instrument (such as a questionnaire). Within this error category, sometimes people use to distinguish a particular error "blamed" to the observer, called the "observer error". Sometimes, this happens when a response by a participant might be misinterpreted by the researcher or interviewer, and recorded information is incorrect because the response is not what the participants intended it to be. However, due to it being a trustable member of the community and my expertise in running interviews/focus groups, this error has been limited.

In summary, various strategies were implemented in this study to limit these potential errors and biases. One of these tasks was to provide data collection training and supervision for both research assistants and participants, giving them clear and straightforward instructions in taking measurements and feedback. This guarantees the quality and integrity of the data collection procedure. From planning, data collection through to analysis, these factors all contributes to limiting these errors, which also included my training as a qualified Lifestyle Coach; my knowledge around the Tongan culture and protocols; being able to write and speak in Tongan fluently to ensure participants in the adaption process and evaluation understands the questions and tasks; awareness of participants characteristics; testing the sampling instrument (questionnaire); my expertise in running interviews/focus groups; and being an identified trustable member of the community.

6.1.3 Other limitations

Other limitations that this study had faced and should be taken into consideration is the impact of the covid-19 pandemic which occurred during my study period. It had affected the delivery and the implementation of the STM-DPP, which was evident in the focus group

data from the participants that 'did not complete' the study. The issues of impact ranged from community sampling and the generalization of the findings to other population groups, and the validation of the PDRT.

6.1.3.1 Impact of Covid-19

One of the limitations with the study was the impact of covid-19 on the delivery of the modules and the ability to do group exercise. The modules were being presented online via zoom due to the uncertainty of lockdowns had prevented and restricted the advantages of having face to face dialogue where the conversation tends to flow much more naturally than online. Some of the modules which include physical aspects such as healthy cooking, shopping was not able to be delivered because of the restrictions imposed in Auckland city. The exercise sessions which started at the church hall and community centers were stopped during covid-19, and as a result, the exercise sessions for the church were being carried out online, however it may not have the same impact, had it been carried out face-to-face. The participants were also encouraged to do their own exercise during the restrictions of covid-19, but this individual approach may not have had the same impact.

The concept of "ngaue fakataha" or working together is important in the Tongan cultural context. They feel more inspired and motivated working as a group compared to working individually, hence the impact of covid-19 lockdown and restrictions actually impacted on their ability and continuity to exercise as a group as the programme provided two intense exercise session during the week. Although, the restrictions of two meters apart still allowed them individually or within their own bubble to go for a walk or a run, it was not as motivational compared to the group exercise activities.

6.1.3.2 Community sample vs Clinical sample

This project used a community sample as described earlier in methods section 4.41 which is the most commonly used method of sampling. There are a few advantages of using the community sampling in this study: 1) it directly assesses the practical effect of a change in behavior or lifestyle, and other adjustable exposures on the occurrence of disease; 2) community sampling has the capacity to regulate the eligibility into the study, administration and delivery of the prevention programme, and be able to monitor the results(143); and 3) it was cost efficient both in time and financial resources. Nevertheless, they do have limitations, with the most significant one being the inability to assess or regulate variability and bias. Furthermore, the findings obtained from the data cannot be extrapolated beyond the specific community members involved(155).

On the other hand, clinical sampling such as randomized controlled trials offer several benefits. They are regarded as the benchmark in study design due to their ability to; 1) reduce confounding factors that might impact the outcomes; 2) offer the most reliable information regarding the efficacy of a treatment; 3) results can be generalized to other population 4) utilized in many fields like medicine, vaccination trials, and behavioral economics; and 5) used as a foundation for drug regulation and the establishment of national guidelines and policies. Although it is seen as the gold standard for research, RCTs do have its limitation including 1) designing and conducting them can pose challenges, and require a significant amount of time, and can be very costly; 2) small or underpowered trials may be limited by factors such as selection bias, inability to differentiate outcomes, and imprecise point estimates. It is of great importance though that researchers do not assume the benefits of a prevention programme

in using the community sampling or clinical sampling, but to be able to quantify and properly evaluate whether a program has achieved its intended objectives.

6.1.3.3 Generalizability of the findings to other population groups

As convenience sampling was used, one of the limitations in this study was that the study findings cannot be generalized to other population groups. The cultural factor plays an important part in the adaptation, implementation and evaluation of the STM-DPP. All different ethnic groups have their own culture and hence the findings in this study, which incorporates the Tongan culture, cannot be generalized to other non-Pacific Island population groups.

6.1.3.4 Validation of the Prediabetes Risk Test (PDRT)

In 1993, the American Diabetes Association (ADA) issued its first prediabetes risk assessment tool. The risk assessment was modified from previously conducted research and validated in 2008 using data obtained from the CDC. Using a representative sample in the US, the predictive value was 10%, while the specificity and sensitivity were 79% and 65%, respectively (156). Only health-related characteristics, such as age, height, and weight, were included in the evaluation; blood sugar and cholesterol were not included. A person has a much higher chance of developing prediabetes if they receive a score of five or higher on the online risk assessment.

Despite the PDRT being a cost effective and simple tool to use, this tool has been developed and validated among the American population (157). Research has shown that correlation between ethnicity, race, socioeconomic status, geographical location, and other biological

traits and the occurrence of prediabetes and T2DM (158) (159) questions the tool's external validation.

In a study by Jadhav et al (2023), to detect for prediabetes among the Indian population, they determined that the PDRT has a sensitivity of 48.1%, specificity of 95.5%, positive predictive value (PPV) of 66.1%, and negative predictive value (NPV) of 90.9% for detecting prediabetes. The use of PDRT in accurately identifying individuals with prediabetes may be limited among the Indian population. Nevertheless, it is advantageous to ascertain the accurate negatives. In order to enhance the applicability of PDRT in the Indian context, more study is required to adapt the instrument accordingly (157). Nevertheless, recognising the genuine negatives can prove to be advantageous. Additional research is required to modify the PDRT to suit the Indian context in order to make it more appropriate for Indians. Nevertheless, an official diagnosis can only be determined by a blood test.

Another study by Aldayel, Belal, and Alsheikh (2021) evaluated the American Diabetes Association (ADA) and the CDC prediabetes risk test in detecting Saudi Arabian individuals who were at risk of developing T2DM reported its sensitivity was 78.9%, specificity was 82%, Positive Predictive Value (PPV) was 32% and Negative Predictive Value (NPV) was 76% (160). The ADA/CDC prediabetes risk assessment tool was characterised by a high level of sensitivity and specificity in accurately diagnosing the presence of the illness. This tool was highly sensitive and specific in identifying the risk, although its use in Saudi Arabian individuals was limited. Hence, future research should investigate the efficacy of the instrument in evaluating risks in other local populations in Saudi Arabia. In the context of this study, the limitation of using PDRT is that it has not been externally validated within our Tongan population. Risk

factors for prediabetes and T2DM includes ethnicity and geographical locations which was not taken into account in the original validation (160).

6.2 Summary and explanation of key results of the STM-DPP

6.2.1 Univariate analyses

The results are discussed in the order they were presented**:** clinical markers, PDRT, and Diet Diversity. Due to the limitations of the study sample previously outlined, the comparisons of interest are limited to a description of the variables by sex. The study results are compared with findings from available and relevant DPP findings, as well as relevant national and international studies.

6.2.2 Clinical Markers

The clinical markers which included data collected on the participants weight, waist circumference, WHtR, 6 minute walk test, blood pressure, and Prediabetes Risk Tests were measured at baseline and at the end of the six months of the programme. The results presented a positive impact of the STM-DPP programme on the participants' biometrics indicating legacy of the efficacious DPP work.

6.2.2.1 Waist to Height Ratio (WHtR)

Central obesity as measured by the WHtR has been suggested as a more accurate predictor of cardiovascular risk (161). This measure was used to answer the present conundrum of how to detect most effectively "early health risk" using an easy and inexpensive anthropometric assessment. Fat distribution may be estimated from the waist-to-height ratio. As a proxy for obesity, the waist-to-height ratio increases one's risk of cardiovascular illnesses in those who

are overweight or obese. Researchers have shown that the waist-to-height ratio is an excellent predictor of cardiovascular disease.

In this study, post-intervention, on average the participants' WHtR had reduced by 0.02 (0.69 – 0.67) and this was statistically significant ($p<0.0001$). However, despite the overall participants' reduction in the WHtR, 40 out of the 41 participants (97.5%) still had a very high WHtR (i.e., greater than 0.5), which suggests that almost all of the participants in the STM-DPP had a pre-existing health condition or they were at an increased risk of developing serious heart health issues (162). This is not an unusual finding, particularly for Pacific peoples in NZ and those living high deprivation, as they are over-represented in poor health outcome statistics (25) (163).

A recent study found that WHtR is strongly correlated with T2DM and impaired fasting glucose (IFG) (164) (165). The measurement is useful in predicting T2DM; and the correlation between WHtR and T2DM were mediated by the homeostasis model assessment of insulin resistance (HOMA-IR), systolic blood pressure (SBP), lipids and other liver and kidney indicators (165). Body mass index (BMI) and the waist-hip ratio are also further measures of central obesity but WHtR is a much better predictor for cardiovascular risks (59) (166) (167). According to the standard recommendations, a WHtR that falls anywhere between 0.4 and 0.49 is regarded to be healthy (168) . If it's less than 0.4, it may deem an individual as being underweight . On the other hand, scores that are larger than 0.5 suggest that there is a greater likelihood of health problems caused by an excessive amount of body fat (169) (170).

Waist circumference reduction can increase energy and decrease the likelihood of developing health problems including diabetes and heart disease (171). There is credible evidence that central adiposity can increase the risk of death (172). If the same anthropometric index and clearer public health messages can be utilized throughout adolescence communicating the warnings about potential health consequences, then elevated health risks for could be prevented.

Waist-to-height ratio is believed to provide a more straightforward measure of health risk in children compared to body mass index (BMI), since it does not need to be adjusted for age or sex. There is less knowledge on the efficacy of WHtR in various ethnic groups. A study by Goulding (2010) investigated the WHtR cut points linked to BMI definitions of overweight and obesity in a sample of 3,006 NZ children aged 5 to 14 years. Anthropometric measurements, including height, weight, and waist circumference were collected. From the sample, 36.8% were Māori children, 32.7% were Pacific and 30.7% were NZ European and Other ethnicities (NZEO). They found that WHtR ≥0.5 was more prevalent among Pacific children (43.4%) and Māori children (33.1%) compared to NZEO children (20.8%, $P<0.001$). Overall, 25.6% of children exceeded this threshold. While ethnicity had a substantial impact on the connection between BMI and WHtR ($P<0.01$), the differences were not clinically meaningful. However, the current findings indicate that WHtR values ≥0.5 were similarly effective in assessing cardiovascular health risks in Māori, Pacific, and NZEO children (173).

Research by Frayon (2018) assessed the effectiveness of WHtR in predicting the percentage of body fat (BF%) in a diverse group of teenagers from New Caledonia, aged 11 to 16 years, as compared to values based on BMI. It also investigated whether WHtR >0.5 could effectively

identify individuals with excess body fat, while having a normal BMI. Body fat percentage, BMI, and WHtR were computed for New Caledonian teenagers of diverse ethnic origins using skinfold measurements. The association between BF%, BMI, and WHtR was established using quadratic models and linear regression equations. The study evaluated the accuracy of WHtR in identifying adolescents with excess body fat (BF% in more than 25% of males and 30% in females) and compared it to the categorization based on BMI. The study found WHtR had a stronger connection with BF% compared to measures based on BMI. The WHtR was shown to be more accurate than the BMI in identifying overfat adolescents when the WHtR value was greater than 0.5. Furthermore, while using this specific threshold, it was shown that 8% of teenagers with a normal BMI were classified as being over-fat. Firestone et al (2017) also pointed out in their study of 30 Pasifika youth aged 16 – 24 that the WHtR was 0.6, indicating that the health and wellbeing prospects for the Pasifika youth are unfavourable (174).

It is evident from the current study that WHtR greater than 0.5, suggests that almost all of the participants in the STM-DPP had a pre-existing health condition or they were at an increased risk of developing health issues. This is a common finding that Pacific peoples in NZ and those living worldwide, are over-represented in poor health outcome statistics.

6.2.2.2 Blood Pressure

In this study, systolic blood pressure was found to be lower, and diastolic blood pressure remained significantly higher than normal for all participants. Systolic blood pressure was significantly reduced by the end of the STM-DPP programme, however this marker for the STM-DPP should be taken with caution, because the STM-DPP was carried out over a much shorter timeframe than the standard DPP, and it is highly likely that the participants in the

current study have existing comorbidities that may be masking the true effects of the STM-DPP. Qualitatively, there were other factors that may have affected the participants' systolic blood pressure included: worrying about their health status; anxiety of whether their health would improve after the STM-DPP ended; nervousness; lack of sleep; early morning activities (like walking or jogging to the Community center); consumption of caffeine; and whether they will cope in participating in the exercises.

A study by Hagberg (1987) found that individuals with essential hypertension experience a significant decrease in systolic and diastolic blood pressure after exercising. The researchers conducted a study on 24 individuals aged 60-69 years old with recurrent essential hypertension. They exercised at different intensities with systolic pressure decreasing during recovery, while diastolic pressure remained unaltered. The decrease was primarily due to a decrease in heart blood pumping, while overall blood vessel resistance increased during recovery. The cardiac output decreased due to a decline in stroke volume, which could not be fully explained by changes in plasma volume. The study suggests that additional processes affecting blood return to the heart and heart muscle contractions were responsible for the decrease in systolic blood pressure after a single session of moderate exercise (175) . Although in the current study it was difficult to measure this kind of process, it could be a plausible explanation. Another plausible reason that may explain why systolic blood pressure dropped while diastolic blood pressure remained unchanged, could be aligned with a study by Brett (2000). The study examined the impact of training intensity on blood pressure and other cardiovascular risk in 55 year old sedentary individuals. The study employed a randomized crossover design, consisting of three 10-week periods. The findings indicated that engaging in both low and high intense training activities resulted in greater improvements in

aerobic power and decreased resting systolic blood pressure. However diastolic blood pressure lowered only for those doing high intensity exercise but not for those with lower intensity (176). In the end, a more probable explanation of the high blood pressure readings need to take into account those factors explained previously and including that 40.5% of participants have other diagnosed health conditions; 73.2% have a family history of diabetes; and 36.6% are currently on medications. Despite this, the clinical parameters briefly discussed above have been trending in the right direction after six months of the STM-DPP, with improved weight management and increased level of exercise as a significantly positive outcome .

6.2.2.3 Prediabetes Risk Tests (PDRT)

For the STM-DPP participants, there was no change from baseline to post- programme. In the current study, only three people had significantly lost a total body weight of 23.5kg, 14.7kg, and 13.5 kg, respectively. Although, the weight loss was quantitively large, these three participants were still considered to be at risk of having prediabetes. The implications of using this tool for screening for T2DM risk highlights several issues of consideration: 1) It does not take into account one's ethnicity or race in the scoring; 2) It does not take into consideration other health conditions other than being diagnosed with high blood pressure or gestational diabetes for women; 3) Anyone who is younger than 40 years have zero points allocated to their score, although research has shown that the incidence of T2DM is prevalent in younger age groups, especially for those with a family history of T2DM (177) (178) (179); and 4) there is uncertainty as to whether this test can be used outside the USA and still hold its external validity.

Several international studies have used different tools and procedures to assess or screen for prediabetes and T2DM. The study conducted by Tankova et al. (2012) assessed the effectiveness of HbA1c as a diagnostic tool for prediabetes, impaired fasting glucose, and newly diagnosed T2DM.Their results showed that HbA1c was significantly higher in groups with altered glucose tolerance compared to those with normal glucose tolerance. The HbA1c performed well for diagnosing diabetes and prediabetes, with an optimal cut-off level of 6.1% for T2DM and 5.5% for undiagnosed prediabetes. The study identified HbA1c as a useful and reliable tool for identifying prediabetes and diabetes (180).

Another tool used for screening is the oral glucose tolerance test (OGTT). Research by Camacho et al (2016) involving 218 asymptomatic adults at risk for T2DM found no concordance between hemoglobin A1c and the oral glucose tolerance test (OGTT) for diagnosing prediabetes among Hispanic and non-Hispanic white (NHW) populations. The study found that A1c is discordant with OGTT for prediabetes in both groups. The study suggests that sole use of A1c to designate glycemic status may result in a greater prevalence of prediabetes among different ethnic groups (181). Another study investigated the ability to replicate oral glucose tolerance tests (OGTT) in a sample of 212 Chinese participants. The overall repeatability rate was 65.6%. Out of the total number of individuals, 74 had normal glucose tolerance, 24 had T2DM, and 41 had impaired glucose tolerance. The participants were categorised into three categories: one group with normal characteristics, and two groups with aberrant characteristics. The findings demonstrated inadequate consistency, especially among individuals with elevated HbA1c, BMI, or waist to hip ratio. Individuals who exhibited one abnormal oral glucose tolerance test (OGTT) displayed a greater cardiovascular risk profile in comparison to those who had two normal OGTT results. The study emphasises

the necessity of enhancing testing techniques to provide precise glucose tolerance testing (182).

The acceptable diagnostic test for diabetes in Korean is the HbA1c test . However, national standardisation is required for its use as a diagnostic method (185). A study conducted in Canada by Rosella (2015) made a similar discovery, indicating that the prevalence of undiagnosed T2DM and prediabetes was substantially higher when HbA1c levels were used in comparison to FPG levels.

The study by Jeon (2013) assessed the prevalence of T2DM using fasting plasma glucose (FPG) levels or a combination of FPG and HbA1c. The results indicated that the use of FPG alone may underestimate the prevalence of T2DM and prediabetes. The study determined that when HbA1c was incorporated as a diagnostic test, the prevalence rose to 12.4%. The acceptable diagnostic test for diabetes in Korean is the HbA1c test. However, national standardisation is required for its use as a diagnostic method (183). A study conducted in Canada by Rosella (2015) made a similar discovery, indicating that the prevalence of undiagnosed T2DM and prediabetes was substantially higher when HbA1c levels were used in comparison to FPG levels. The study involved 3,494 non-pregnant adults aged 20 and above and they used blood glucose measures that met Canadian guidelines for T2DM. The undiagnosed prevalence was 1.13%, contributing to about 20% of total T2DM prevalence. The results highlighted that the prevalence of prediabetes increased three times overall and by sixfold among females when HbA1c was used as a measure, however further assessment is required to evaluate the full impact of utilising HbA1c (184).

A thesis by Heath (2012) carried out a study to assess the efficacy of prediabetes and T2DM screening techniques by gender and race/ethnicity. An assessment of screening results was conducted in a sample of 10,566, multiracial men and women using the National Health and Nutrition Examination Survey (NHANES). The findings demonstrated that for racial and ethnic minorities, the HbA1c test was associated with the FPG and equivalent in terms of precision. Compared to the traditional FPG screening approach (42-49%), the HbA1c test has greater specificity (64-66%) for diagnosing prediabetes. Regarding the efficacy of screening, there were no notable distinctions between men and women. According to the study, racial and ethnic minorities may benefit from using the HbA1c test as a screening tool for prediabetes, which could help delay the onset of T2DM(185).

In summary, although the PDRT used in this study was used as a proxy screening tool rather than using the HbA1c or other blood glucose tests (FPG and OGTT) to reliably test for prediabetes and T2DM, it was still an appropriate tool to use in the current study, particularly given the covid-19 restrictions and the project was conducted in a community context. The FPG and OGTT have their own limitations, and the only concern is whether the PDRT has external validity if used outside the US context and population groups.

6.2.2.4 Diet Diversity

A Pacific Diet Diversity questionnaire was used to observe food habits over a seven-day period. Over the past 7 days (included 5 weekdays and 2 weekends days), the participants primarily consumed two food types: (Food type 1) Protein and Vegetables composed of meat, poultry, fish, fruit, and vegetables; (Food type 2) Junk Foods composed of a wide variety of snack foods, both sweet and savory, as well as fast food.

Based on the exploratory factor analyses, Food type 1 included meats such as, lamb or mutton flaps, beef, pork, corned beef, cured meats such as povi masima, ham, bacon, fish and tinned fish, shellfish, chicken, eggs, and other meats. The majority of these meats would be considered to be cheap fatty meat, as lean meats are more expensive. The fruits included a diverse range of 37 items, purchased from local produce, such as, apples, pears, orange, mandarin, feijoa, persimmon, grapes, and some imported fruits such bananas, pineapple, watermelon, etc. The vegetables were also diverse, including onions, cabbage, silverbeet, taro leaves, carrots, celery, cucumber, pumpkin, tomatoes, beans, broccoli, cauliflower, lettuce, capsicum, corn etc.

Food type 2 included junk foods such as sweets and savory snacks and take away foods. This study provided important insights of differences in food types consumed between the younger and older Pacific generation. From the EFA analysis, two factor groupings of dietary patterns were found across all participants. The correlation between Factor 1 and Factor 2 was 0.732, which means that participants who ate Food type 1 (meat, poultry, and fish; fruit; and vegetables) also ate foods under Food type 2.

The dietary patterns of Tongans in this study were reflective of the working age of adults (22yrs – 68yrs, average of 44.39yrs) living in Auckland, NZ. Therefore, the dietary pattern may be explained by the age group of the participants and their high socioeconomic deprivation. A similar study by Tupai-Firestone et al. (138) identified three main groups of participants' diets: healthy; processed; and hybrid food groups, using the same dietary diversity questionnaire and analytical process. In their study, dietary disparities between the older and younger generations showed statistically significant differences in mean food scores, between

the generation groups. The older population ate a wider variety of foods and, on average, a healthier diet than younger generations. The younger generation had a higher prevalence of 'processed diet' consumers. Examining food habits is important for a study such as this one, because dietary input plays an important role in T2DM prevention. The 2008/09 New Zealand Adult Nutrition Survey (NZANS) (186) reported that the dietary habits were associated with eating patterns, nutrient consumption, nutritional status, and health issues. Vegetable and fruit consumption are considered protective factors against chronic diseases, whereas consuming excessive amounts of fat, sodium, and total energy are considered risk factors. The report found that Pacific and non-Pacific individuals often have comparable dietary patterns, with minimal disparities observed in the consumption of margarine, cooking oil, and iodised salt. On the other hand, individuals from the Pacific region, both males and females, have a higher tendency to include fresh and frozen fish and shellfish, processed meat, daily breakfast, reduced fat or trim milk, trim fat from meat, remove chicken skin, and infrequently use salt in their meals. They have a higher propensity to consume carbonated beverages or caffeinated drinks on a frequency of three or more occasions each week. Pacific women exhibit a nearly threefold higher likelihood of consuming fast foods, takeouts, and hot chips three or more times per week. Between 1997 and 2008/09, there was a rise in the percentage of Pacific males and females who consumed two or more servings of fruit per day. Nevertheless, there was no alteration in the prevalence of sufficient vegetable consumption among Pacific individuals from 1997 to 2008/09. In 2008/09, less than half of Pacific males and females were able to achieve this criterion (187).

Dietary pattern findings in this current study are similar in some aspects compared to what was reported in the 2008/09 NZANS for Pacific people. As expected, both the Tongans in this

study and Pacific people surveyed ate foods that were similar; seafoods, poultry, meat, including fruits. However, the consumption of vegetables in the 2008/09 NZANS reported only half those surveyed consumed sufficient amount of vegetables. It also reported that Pacific women were three times more likely to consume fast foods and takeouts three times per week.

Similar studies that have examined dietary diversity have reported somewhat mixed results. O'Meara (2019) study reported that Fiji is currently undergoing economic and nutrition transformations, which are leading to an increased susceptibility to noncommunicable illnesses as a result of shifts in food availability and dietary consumption. It investigated the dietary diversity of indigenous food-producing households in rural Fiji revealing that the majority of homes exhibited a moderate level of dietary diversity, accounting for 66% of the sample. Frequently consumed foods consisted of confectioneries, processed grains, and root vegetables, whereas the least consumed foods were fruits with orange-coloured flesh, vegetables, eggs, legumes, and dairy products. Households exhibiting moderate dietary diversity had a higher probability of being unemployed, but a lower likelihood of having inhabitants purchasing food more than twice a week. Inadequate nutritional variety resulted in limited agricultural variety and reduced work opportunities. Public health activities should advocate for the promotion of traditional diets and agricultural initiatives that aim to enhance farm diversity throughout nutrition changes (188).

It is also important to note that a limitation in this study using the Dietary Diversity questionnaire is that it is not a validated tool and therefore the findings should only be characteristic of the participants of this study and therefore it cannot be generalized to other

Pacific groups or Tongan people in general. Furthermore, the two identified food groups in this project are highly likely to be associated with socio-economic deprivation because of the limited food supply due to the covid-19 pandemic when globally and nationally food distribution was readily available or transported.

Assessing nutrition and food consumption of individuals for research and monitoring purposes is well recognised as difficult to collect and it is prone to both random and systematic measurement inaccuracies. There are advantages and drawbacks of existing approaches for evaluating dietary and supplementary exposures. Conventional approaches to evaluating diets involve keeping records of food consumption, answering questionnaires on meal frequency, recalling what was eaten in the past 24 hours, and using screening tools. However, there are now digital and mobile ways that utilise technology to assist with these conventional procedures. The selection of the assessment method ultimately depends on factors such as the research topic, study design, sample characteristics, and sample size among others, although they may present difficulties, dietary assessment methods play a crucial role in nutrition research and monitoring.

The 24-hour Recall, Food Record, and Food Frequency Questionnaires have traditionally been used in diet-related and nutritional-based research. Both the 24-Hour Recall and Food Record are similar across various dimensions of interest, and they have the same scope of interest regarding total diet, short term time frame of interest, enable cross cultural comparisons, take more than 20 minutes to complete, low cognitive difficulty, and are ideal for cross-sectional and prospective study designs. However, Food Records have higher potential for reactivity

compared to 24-Hour Recall and that it does not have any memory requirements compared to the 24-Hour recall (189). The frequent food questionnaire (FFQ) was not used in this study as there is current debate regarding issues assessing nutrient estimates. Also, Briefel (1992) argued that the FFQ tool lacked evidence of producing accurate nutrient data that can be used as a reference for the population, especially pertaining to: 1) the nutritional estimation assumptions; 2) interpreting statistical data and ensuring validity; 3) the thought processes of the respondents; and 4) accounting for culture sensitivity (190). Kristal, Peters and Potter (2005) also reported that the FFQ lacked sufficient dietary evaluation (191).

6.2.3 Weight and Physical Activity

Weight loss management is key for any kind of T2DM intervention. The main finding in this study is that participants had significantly reduced their weight on average by 5.4 kg after 6 months on the STM-DPP. Men lost an average of 7.1 kg and women lost an average of 2.8 kg. The loss in weight for both males and females were significant, with p-values of $p<0.0001$ and $p<0.038$, respectively. The weight differences between baseline and post-prevention programme were statistically significant for all participants ($p<0.0001$). The reduced weight management was significant with 58.5% of all participants achieving a weight loss of 5% or more, while 29.3% achieved 7% of weight loss or more. This weight loss was expected given that the STM-DPP was adapted from an established efficacious DPP programme. However, from a STM-DPP perspective, the participants had reported that they were empowered and inspired through the programme, and there was social cohesion amongst the participants as they relied on each other for support, including the church and the community leaders.

Additionally, participants were able to receive counsel from myself outside of the programme and via the zoom sessions. Therefore, the regularity of the support given to participants may have also partially explained the significant weight loss management over a shorter period of time (6months), because the participants reported various challenges along the way and this was compounded by the covid-19 pandemic restrictions, so the online counselling was an important factor. Being physically active is also an explanatory factor for the weight loss, as people had more time to get involved during the covid-19 restriction period. The STM-DPP recommended 150 minutes of moderate exercise per week or 30 minutes or more a day.

This project used the 6MWT to measure general fitness. The project finding showed that participants had on average, increased the distances walked in six minutes from 478.2m to 576.2m ($P<0.0001$), and they walked on average 98 meters in 6 months, which was very encouraging. In addition, the unpredictability of the lockdown was unsettling, but the constant communications with participants, the group Facebook, and the zoom sessions kept motivated the participants to continue being involved in the study. A study by Grove, Jones, and Connolly (2019) of participants in a cardiovascular prevention and rehabilitation program, had used supervised circuit training sessions lasting up to three months, during which participants were motivated to engage in a home fitness exercise programme two-three times per week. The current study found that the 39 high-risk patients had improved their 6-minute walk test distance on average by 40 meters (192). Interesting research by Ekman (2012), also used the 6MWT among 251 obese participants were assessed before and after a weight reduction program, found the walking distance at baseline 535m (480-580) had improved at follow-up to 599m (522-640) after 6 months. Their weight reduction programme resulted in an improvement in the 6MWT of an average of 64m (193). The current study aligned well to

Ekman's study showing improved physical activities as characterized by the 6MWT improvements. However, it is difficult to know whether the 6MWT is generalizable to overall physical fitness and health, and unfortunately this was not captured in the current study, but it should be included as an important avenue to explore in future studies. A study based in NZ by Higgs, Skinner, and Hale (2016) investigated a three month community-based lifestyle programme designed for individuals with T2DM/prediabetes to assess its results and acceptability. The programme consisted of self-management instruction and exercise sessions, overseen by physiotherapists, students, and nurses. Thirty-six participants were recruited to the programme and after three months, their 6MWT improved on average from 420m (104) at baseline to 529m (109), an improvement of 87m (65 – 109). The programme was determined to be both safe and culturally acceptable and was beneficial to the participants. The lifestyle programme has the potential to be replicated in different areas and among individuals with comparable chronic ailments (194). The 6MWT results in this current study is comparable to the studies described above, and it highlights significant improvements in the 6MWT results can contribute to improved lifestyle and physical activity levels.

Overall, the lifestyle changes and the effect of the STM-DPP had significantly decreased the weight of the participants within 6 months, suggesting that these results will go a long way in preventing prediabetes.

6.3 Evaluation of the STM-DPP

At the completion of the STM-DPP, the evaluation phase was undertaken which involved two focus groups, with three major themes identified, which will now be discussed.

6.3.1 Participants who did not complete the STM-DPP

The first them relates to the *Positive Structure and Effectiveness of the STM-DPP*. The program brought to light its “positive structure” approach, providing participants with enough knowledge and information to achieve their goals without making significant non-realistic changes. The program provided weekly reminders of key messages and outcomes, and the participants enjoyed the programme particularly during the challenging lockdown periods. Participation in the program helped to keep the participants on track with the content and information offered, making it beneficial for their wellbeing.

The program's “effectiveness” was attributed to its transformational changes in lifestyle and behavior, based on the well-known effective DPP initiative. This awareness increased participant confidence encouraged behavioral change, and it was the biggest impact of the program. The program's name, Sia, translates to "weaving like fishing nets," and its progressive approach ensured participants can take on and apply knowledge without significant non-realistic changes. The program's effectiveness was attributed to its ability to provide transformational changes, fostering confidence, and encouraging behavioral and mindset changes.

The second major theme referred to the *Constructive approach of the programme*. The STM-DPP was seen to be constructive and highlighted “family support and participation” as an

important aspect of the programme. The STM-DPP used a family approach and one participant in the programme alluded to participating in the program to support his three daughters lose weight, as a result it has helped them change their lifestyle .as a whole family. Another participant appreciated the opportunity to participate as a family, which was the first time they had a program available at church. Another found the program easier to follow as they were able to change their diet and didn't have to cook more than they were eating.

In the Tongan society, kinship is crucial, and the term “fāmili” refers to one's immediate family, while “kāinga” refers to the extended family. Fathers in Tongan households are held in high esteem, and respect is prevalent among the family, community, and village. The function of parents is crucial as they lay the basis of “ilo” (knowledge) and “poto” (wisdom) inside the family and at home. Once the father gives the approval or gives their blessing for the family to participate in a programme or other activities, then it is likely that they will be successful in achieving the goals and objective of that programme, because the whole family supports the programme.

Food plays a pivotal role in comprehending Tongan culture and has significant importance for a number of reasons; it serves as a fundamental element of social interaction; represents one's social standing; and establishes a link to the land and traditional knowledge. It holds great significance for Pacific islanders, since it fosters a sense of community, and the value of providing excellent hospitality is deeply rooted in their culture. In the Tongan culture, it is better to have more food than enough as running out of food is seen as an embarrassment to the family, especially if you have visitors to your home. However, this is an issue relating to quantity of consumption, something that the Tongans do struggle to come to terms with

where Tonga was reported in 2016 by the BBC to be the most obese country in the world with approximately 40% having T2DM (195). The quantity of food consumed were emphasized in the modules such as caloric intake so that participants know what and how much food they are able to cook and consume.

An important aspect of the STM-DPP is that it is "accessible and inclusive". Despite the eligibility criteria to participate in the programme, the family approach allowed everyone in the family to participate regardless of their age, especially in the group exercise activities where children from age five years old to the elderly joined the exercise sessions. One participant said that: *"It was open to all age groups and not just for those at borderline diabetes",* and that was why they loved the programme because it was accessible and inclusive.

"Motivation and education" were also a big part of the STM-DPP. One of the participants highlighted that she liked *"the programme because it motivates"* her and that her *"weakness is the food"* but the *"zoom sessions helped and educated"* her in what to eat. Another participant mentioned that the the main lessons she learnt were related to her health and lifestyle. One particular quote that stood out to her was *"you'll never change your life until you change something you do daily",* a quote that motivated her to change her lifestyle and also inspired her to help her family change their lifestyle as well. Rise et al (2013) highlighted that acquiring knowledge was crucial for implementing lifestyle modifications after receiving an education about T2DM. The study found three determinants that influenced the implementation of lifestyle changes; acquiring new knowledge; assuming accountability; and getting validation of an existing healthy lifestyle. It also found four key variables that

motivated participants to sustain changes: receiving support from others; observing the impact of the changes; fearing potential problems; and developing a new lifestyle (196).

The health and wellbeing benefits highlighted the success of the STM-DPP. One of the participants stated that he has lost the pain in his legs due to living a healthier lifestyle, performing more exercise, consuming less volume of food, and as a result saving money that he would usually spend on food. Another said that he has already been reaping the benefits of the STM-DPP, when he noticed weight loss and having the capability to run up to seven kilometers. Overall, the most evident indicator of the health benefits from the STM-DPP was the visible weight-loss and becoming more active.

The third major theme referred to the *educational modules and online interactions*. The participants who completed the STM-DPP emphasized the positive bio-feed back and many participants found their participation in the programme was a great learning experience. Although the STM-DPP was successful and participants enjoyed the programme, some faced challenges and were not able to commit to all the exercise and zoom sessions due to work and family commitments.

Another major theme from the evaluation pertained to identifying the *Motivators and Enablers of the STM-DPP program* was found to be “effective and positive”, with key enablers such as “group-based activities” and a “safe and caring environment”, had enabled the participants to remain in the study with confidence. Another motivation to participate was due to having a known “family history of T2DM” and the STM-DPP was an opportunity to break the family history of T2DM and help the next generation to break this circuit. The

relationship between the researcher and fellow participants also aided the “encouragement and support” within in the group enabling participants to remain in the program. Higgs, Skinner, and Hale (2016) highlighted two themes that came up in their community-based lifestyle programme for adults with diabetes or prediabetes; 1) social support; and 2)self-management (194). The theme "social support" emerged from the relationships formed among the staff, physiotherapy students, and participants. The theme of "self-management "emerged from the program's ability to enhance motivation, confidence, safety, and empowerment (194). They also reported that social support was a key factor in the acceptability of exercise programs for individuals with diabetes and prediabetes, which supports the “encouragement and support” sub theme in this current study, as it also improved participants' self-management skills. This empowerment led to increased motivation, confidence, and a sense of safety in the STM-DPP project environment.

One of the major findings from the evaluation phase of the study was the *church-support environment.* The church support and environment enabled and encouraged the participants to remain and continue for the duration of the programme. The STM-DPP was found to be more successful in a faith-based environment (South Auckland Site) compared to a non-faith based (West Auckland Site), because the church is central to the Tongan participants. According to Panapasa et al, faith-based organizations tend to have high participation rates, as characterized by the support and leadership from the church hierarchy, and this has certainly played an instrumental role in implementing the STM-DPP study (197) . Similarly, a study by Parks et al (2022) also reported that the faith leaders in the churches played a significant role in encouraging people to be involved in the study (109). This support mechanism not only enhances and encourages participants to make lifestyle changes, but it

also demonstrates that the Head of the church do care about the physical, mental, and spiritual wellbeing of their church members, and vice-versa. Members also felt familiar and comfortable within the church environment as the setting for the research project.

The fifth major theme identified from the STM-DPP relates to the processes that were successful as perceived by the participants. Processes included: capacity to directly engage with the participants; having a medical professional available to provide confidence to the participants; flexibility and back-up-plans; simplification of the DPP and PI-DPP materials as a result of the adaptation process; implementation of the practical strategies and the programme drivers (the Lifestyle Coach and the modules).

The participants expressed their satisfaction with the processes of the STM-DPP, due to a range of successful factors. Firstly, the physical and learning aspects of preventing T2DM by way of improving weight, and living a healthy lifestyle, which for the most part was due to the 23 educational-based modules that focused on building relationships, changing eating habits, and improving behavior, including sleep. These were essential to increasing participant knowledge and skills to help them live longer and to better understand how to prevent T2DM. Secondly, the participants also believed that the programme enabled them to remain on track and at the same time be flexible, because it allowed them to change their diets and not have to cook more than they were eating. Thirdly, the programme also helped participants to identify their vulnerabilities and to improve their overall health. The regular zoom meetings were very informative and helpful and played a role in motivating participant retention. Fourth, the participants were motivated to participate and continue with the STM-DPP as they were able to talk, discuss their experiences of living with T2DM. Leaning about the disease

and its impact on their families had empowered and inspired them towards living a healthier lifestyle. Finally, the ongoing communications from the researcher (as the Lifestyle Coach) highlighted positive aspects of being part of STM-DPP, such as, receiving support and encouragement through emails, text messages, and through online interactions. The constant communication lines of interaction did enable participant retention and reduced the attrition rate, as it kept participant goals at the forefront of their involvement.

Another major finding was identified through the practical applications and implications of the STM-DPP. The programme created good daily habits for the participants, and this was characterised by the participants expressed desire for more health initiatives in the church context, as they have found the modules were applicable to whole families within their church setting. The importance of family participation, simplifying assessments, setting short and medium goals, and sustaining lifestyle changes long-term were important pragmatic processes.

Further, the participants described their experience with the STM-DPP to have significantly improved overall wellbeing. The STM-DPP had also helped them understand the effects of T2DM and its preventability, which they believe is a significant step towards a healthier and longer life.

6.3.2 Participants who did not complete the STM-DPP

Despite the positive feedback regarding the STM-DPP, there were barriers and challenges that participants faced relating to completing the programme. The barriers in participating in the STM-DPP were primarily compounded by the covid-19 lockdown periods in Auckland, which

had regional-wide restrictions for over three months. This had challenged participant retention in the study, albeit the support of family members and the constant lines of communication with the researcher were crucial to success (as described above). Other barriers faced by the participants, included limited access to exercising (communally), nutritious diet due to cost, and time management due to work shift rosters, or routines were changed due to working from home or returning to work. The STM-DPP encouraged walking while working, but shift work made it difficult for some participants to exercise during work or after work. Major barriers for participants included time constraints; work commitment, schedule, and type of work; health conditions; and lack of group exercise opportunities. The participants also faced challenges such as dietary changes and difficulty to consistently log their food and exercise. It is possible that 'participant readiness' may play a role here, as some participants may not have the mindset ready to change their behaviours and lifestyle, due to the demands of home and work life commitments.

6.3.3 Successful STM-DPP processes for engaging the people in the programme

Having the capacity to engage directly with the participants and build that relationship goes a long way to making this study successful. This included constant email reminders and text messages to participants reminding them of the upcoming zoom or exercise sessions. Not only that, messages of encouragement and support for participants were vital when engaging with the participants. The use of the zoom platform to deliver the modules, especially during the covid-19 lockdown was another successful process of the STM-DPP. In fact, the plus-side of the covid-19 was that it allowed the researcher to have high levels of engagement with the participants and the number of attendances were high due to participants not being able to go to work.

Exercise sessions were held twice during the week at the church hall at the South Auckland site, and the covid-19 lockdown resulted in the exercise session being held online. The participants also highlighted the fact that when the researcher was engaging with the participants, he had a "positive and focused nature". Also having a GP available at the baseline data collection and during the zoom educational sessions provided confidence to the participants as they had the opportunity engage and ask questions directly to the GP relating to medical issues.

The process of simplifying the DPP and PI-DPP resources was necessary to reduce the amount of information participants required to complete and adhere to during the programme. The main goal was to exercise a minimum of 30 minutes a day and attend the zoom sessions once during the week. As there was no incentive for the participants, the STM-DPP encouraged participants to stick to their main goal and try and lose 5% or more of their original weight.

6.3.4 Benefits and practical applications of the STM-DPP

The benefit of STM-DPP has proved to be successful in reducing weight by 5% or more of body weight in six months, resulting in the reduction of risks of prediabetes and T2DM. The knowledge participants had acquired particularly on how count their calory intake, the importance of regular exercise to lose weight was a highlighted subtheme expressed in the evaluation phase. Interestingly, the participants did not know what starch food was best for them to eat, however, the education modules enhanced their knowledge of what kinds of Pacific food they can eat (e.g., green banana, taro and yam) which are low glycaemia index (GI) food – the participants understood that these starch foods undergo slower digestion and result in a steady increase in blood glucose levels, which contributes to maintaining more

stable blood glucose levels. The STM-DPP also educated participants to manage their stress through exercising. They know that regular exercise and physical activity can help them manage their weight, increase insulin sensitivity, getting enough sleep, and coping with stress triggers.

6.3.5 Behavioral, cultural, and motivational drivers of change, as perceived by the participants.

It was difficult to change people's behaviour when they have always done things the same way, but in order for the STM-DPP to be successful it was critical that the Tongan culture, values, and principled way of living was embedded into the programme. The behavioural change processes were being implemented with the anga faka-Tonga way of living, which proved to be successful driver of change, as it engaged the participants through a familiar cultural lens and provided a more meaningful approach to working towards a healthy lifestyle. The high intensity participation of the programme during each phase of the STM-DPP was supported by the leadership of the researcher and the heads of the church, which was also a driver of change. Another motivational driver of change was the 'group-based' activities, and this aligns well with Tongans and Pacific peoples in general where collective activities are more preferred than an individualistic approach. The group-based activities provided a sense of motivation, inspiration, support and encouragement. This was also evident in the zoom sessions, as the group zoom sessions provided a safe learning environment.

A supportive church environment is a critical factor in the success of the STM-DPP. As religion and church plays a center role in the lives of the participants. The STM-DPP was more successful in a faith-based environment (South Auckland Site) compared to a non-faith-based

one (West Auckland Site), again it was more likely that the church leaders played a significant role in encouraging participation, enhancing lifestyle changes by attending both the exercise and zoom sessions, and demonstrating the church's care for its members' physical, mental, and spiritual wellbeing.

6.4 Directions for future research

The success of the STM-DPP has paved the way forward for further research in the prevention of T2DM. Other prevention programmes have been successful, however on a larger scale, the DPP and its branch-off constituents (e.g., PI-DPP, PILI, STM-DPP) have shown to be successful because it is a lifestyle intervention. The STM-DPP has shown that implementing a positive lifestyle intervention that includes educational and physical activity components, has a substantial effect on delaying and preventing the development of T2DM among people with prediabetes.

The STM-DPP has also shown that it can be adapted to be culturally appropriate and implemented in other population groups, as it was initially adapted for Pacific Islanders in the USA, where the magnitude of the prediabetes is highly prevalent. The same claim could be made for NZ-based Pacific peoples due to the increasing obesity epidemic and thus the increased risk of prediabetes and T2DM. It is also a cost-effective programme and the STM-DPP has shown huge potential for it to be implemented in a community and church context, without having to an extra effort to leave work and pay expensive fees to see a GP. Therefore, it is largely culturally appropriate, family-lifestyle-based, and cost-effective. A future direction for research would be to tailor the PI-DPP to other ethnic groups (e.g., language, food) and implement the adapted programme.

The resources developed are educational, motivational, culturally appropriate, and improves health literacy for whole families and communities who are high-risk. This was a considered motivational driver of success and requires further investigation of developing engagement processes for the overall STM-DPP. Often the approach has been to focus on the individual with the disease, but as shown in the current project, 'working with groups of families' must be a future-game changer when working towards reducing the rate of disease incidence among Pacific communities. Future research could investigate how to engage whole families in the programme including their involvement in measurements and knowledge development in order to implement behavioural change for all, as well as supporting the family member with T2DM.

CHAPTER 7: CONCLUSION & RECOMMENDATIONS

This chapter discusses the significance and contribution of the main research findings in relation to the research objectives and questions. It discusses the importance of the ideas and issues engendered throughout this thesis and proposes future recommendations.

7.1 Significance and contribution of the main research findings

The STM-DPP study employed the Citizens Panel approach to successfully adapt the PI-DPP. This process was critical as the researcher worked closely with health experts and community members to ensure that the study formed the basis of a strong foundation to build and weave a healthy lifestyle in partnership with the community to take ownership of the programme. The adaptation process emphasized the importance of several key factors, including: i) incorporating Tongan culture and 'anga faka-Tonga'; ii) designing a prevention programme centered around family and community activities; iii) reducing the programme duration to six months, iv) modifying the modules to community education on lifestyle changes, dietary adjustments and increased physical activity; and v) offering incentives to the participants. This adaption process illustrated that the PI-DPP can be tailored to suit not only the Tonga population, and therefore it could be adapted to other ethnic groups.

The implementation of the STM-DPP resulted in positive clinical markers towards a healthier direction with participants losing five percent or more of their total body weight. This finding was expected as it is based on the efficacious DPP and therefore, weight loss management was achievable, but I did not expect this to occur in a much shorter timeframe than the original program. The focus now should be on how to sustain the efforts made during the six-

month programme and to fine-tune the use of which tools could be used to assess biometrics, in particular, that relating to blood glucose tests, diet and nutrition, and the Prediabetes Risk Test. It was clear from this study that established measurements of BMI, blood pressure, and WHtR were accurate predictive estimates that should continue to be used in studies such as this one. The use of the PRDT was a contested factor in this project because it may not be generalizable to other population groups outside of the USA. The tool provided a quick, cost-effective, easy and non-invasive approach to identifying people at high risk of prediabetes which could be used in primary health care organizations' and in the community context. Future work could also look to testing the external validation of this tool in the NZ context and then to prospectively assess its capability to be used by GPs in the community context.

The evaluation of the STM-DPP programme was found to be feasible and acceptable in its ability to alter lifestyle behaviours in high-risk individuals. This was evidenced by the adaptation and positive results in the implementation from the perspective of the participants and community. The study findings serve as a foundation for future implementation of the STM-DPP programmes in NZ that emphasise lifestyle modifications and a family-oriented approach. However, acknowledging certain barriers that limited participants fully participating in the STM-DPP, such as; i) time constraints; ii) work commitments; iii) health reasons; iv) limited group exercise opportunities; v) challenges with dietary changes and difficulties in logging food and exercise. In essence, these are characteristic of the social-cultural determinants of health, but in part, 'participant readiness' should also be an explanatory factor, because the participants need to have that mindset change in order to undertake the programme. The educational modules helped to serve this purpose of preparing the participants for behavioural and mindset change, but this is often where the

participants also had dropped out because the demands of data collection and working with work and family commitments proved to be difficult for these participants. On the flipside, there were notable strengths and enablers of the STM-DPP: as in: i) proven effectiveness; ii) group-based and family-based activities enabling a supportive, joyful and safe learning environment; and iii) the strong endorsement and engagement of community leaders/church heads. For future research, for the STM-DPP to be adapted noting and resolving these barriers and reinforcing and enhancing the enablers needs to be considered so that the programme can be the most effective programme that can accessed to reduce the risk profile of prediabetes and T2DM.

In summary, the STM-DPP demonstrated a promising and practical approach to preventing T2DM in a targeted high risk population group. The adapted programme (STM-DPP) has shown through the high uptake of the programme, acceptability (through the adaptation and inclusion of cultural appropriation) and feasibility (doable in the community and in a shorter timeframe) is evidence-based knowledge that this programme has huge potential to address the growing T2DM epidemic in NZ and among Pacific peoples, and it should be made available to community groups and primary health care services. With that in mind, I propose the following recommendations for future research and work.

7.2 Recommendations

1. Recommend that the government invest in the CDC DPP programme by partnering with them to build a pool of Lifestyle Coaches in NZ. It requires a 12-month lifestyle coaching course to become certified. This means that people (like myself) can implement the STM-DPP and the PI-DPP in the community. This would be advantageous because it will take

the burden off the primary and tertiary level health care services that are already under pressure and undergoing reformation in NZ.

2. To scale-up the STM-DPP work to different Tongan communities outside of the Auckland region, whilst also addressing the barriers noted earlier. This requires careful planning and further funding. However, it will also provide much needed evidence-based knowledge of a community-based prevention programme as recommended by the Social Economic Cost report presented to the NZ government in 2021. The STM-DPP strongly aligns with the report's recommendation of focusing on high-risk ethnic groups, community-based prevention programmes that are culturally centered.

3. Recommendation to the Public Health Policy team at Te Whatu Ora (Ministry of Health in NZ) that the STM-DPP be made available to primary and community health services as a community-wide approach to tackle T2DM risk. This means that the STM-DPP will need to undergo an adaptation process for it to be made accessible for all Pacific Island groups and other high risk ethnic groups (includes Māori and Southeast Asian groups). The adaptation should include a culturally appropriation for these ethnic population groups of cultural values, content of the modules, approach and incentivization.

4. Prediabetes Diabetes Risk Test tool requires further validation to identify if it is appropriate for use in the NZ context. This tool if it can be validated for use in the NZ context it can provide a very cost-effective tool for large scale screening for adults at risk of T2DM by identifying people at high risk of prediabetes. A validation study could be part of the add-on research work, but it is necessary.

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APPENDICES

Appendix 1. HDEC Approval

Health and Disability Ethics Committees

Health and Disability Ethics Committees
Ministry of Health
133 Molesworth Street
PO Box 5013
Wellington
6011

0800 4 ETHICS
hdecs@health.govt.nz

28 January 2021

Dr Ridvan Firestone
Centre for Public Health Research
Massey University
Block 3, Level D
Entrance B, 63 Wallace Street,Mount Cook
Wellington 6021

Dear Dr Firestone

Re:	**Ethics ref:**	**20/STH/154**
	Study title:	New Zealand Pacific Lifestyle Programme (NZPLP): Sia Too'onga Mo'ui Study

I am pleased to advise that this application has been ***approved*** by the Southern Health and Disability Ethics Committee. This decision was made through the HDEC-Expedited Review pathway.

Conditions of HDEC approval

HDEC approval for this study is subject to the following conditions being met prior to the commencement of the study in New Zealand. It is your responsibility, and that of the study's sponsor, to ensure that these conditions are met. No further review by the Southern Health and Disability Ethics Committee is required.

Standard conditions:

1. Before the study commences at *any* locality in New Zealand, all relevant regulatory approvals must be obtained.

2. Before the study commences at *each given* locality in New Zealand, it must be authorised by that locality in Online Forms. Locality authorisation confirms that the locality is suitable for the safe and effective conduct of the study, and that local research governance issues have been addressed.

Non-standard conditions:

- please read through information added to Information sheets to correct typos i.e. taps rather than tapes
- please ensure the GP is contacted directly (in addition to informing the participant) in the event of a significant abnormal test result. Relying on participants to pass potentially important health information on to their health care providers is not best practice.

Non-standard conditions must be completed before commencing your study, however, they do not need to be submitted to or reviewed by HDEC.

If you would like an acknowledgement of completion of your non-standard conditions you may submit a post approval form amendment through Online Forms. Please clearly identify in the amendment form that the changes relate to non-standard conditions and ensure that supporting documents (if requested) are tracked/highlighted with changes.

For information on non-standard conditions please see section 128 and 129 of the *Standard Operating Procedures for Health and Disability Ethics Committees* (available on www.ethics.health.govt.nz)

After HDEC review

Please refer to the *Standard Operating Procedures for Health and Disability Ethics Committees* (available on www.ethics.health.govt.nz) for HDEC requirements relating to amendments and other post-approval processes.

Your next progress report is due by 27 January 2022

Participant access to ACC

The Southern Health and Disability Ethics Committee is satisfied that your study is not a clinical trial that is to be conducted principally for the benefit of the manufacturer or distributor of the medicine or item being trialled. Participants injured as a result of treatment received as part of your study may therefore be eligible for publicly-funded compensation through the Accident Compensation Corporation (ACC).

Please don't hesitate to contact the HDEC secretariat for further information. We wish you all the best for your study.

Yours sincerely,

Mrs Helen Walker
Chairperson
Southern Health and Disability Ethics Committee

Encl: appendix A: documents submitted
appendix B: statement of compliance and list of members

Appendix A
Documents submitted

Document	*Version*	*Date*
Protocol: Research Protocol	Version_2	13 December 2020
CV for CI: CV for CI	FV	08 June 2020
Survey/questionnaire: Health Screen Prediabetes Risk Test	Version_2	20 December 2020
Survey/questionnaire: Quality of Life Questionnaire - SF36	FV	08 June 2020
PIS/CF: Consent Form for Citizens Panel (Phase 1)	Version_2	20 December 2020
PIS/CF: Consent Form for Intervention and Evaluation (Phase 2 & 3)	Version_2	20 December 2020
PIS/CF: Information Sheet for Citizens Panel (Phase 1)	Version_2	20 December 2020
PIS/CF: Information Sheet for Intervention and Evaluation (Phase 2 & 3)	Version_2	22 December 2020
PIS/CF: Schedule for Citizens Panel (Phase 1)	FV	29 August 2020
PIS/CF: Schedule for Focus Groups (Phase 3)	FV	29 August 2020
Flow Chart for Study	FV	29 August 2020
References for online narrative questions	FV	29 August 2020
Evidence of scientific review: Evidence of Review	FV	31 August 2020
Application		02 September 2020
Covering Letter: Covering Letter	Version_1	22 December 2020
Response to Request for Further Information		

Appendix B
Statement of compliance and list of members

Statement of compliance

The Southern Health and Disability Ethics Committee:

- is constituted in accordance with its Terms of Reference
- operates in accordance with the *Standard Operating Procedures for Health and Disability Ethics Committees*, and with the principles of international good clinical practice (GCP)
- is approved by the Health Research Council of New Zealand's Ethics Committee for the purposes of section 25(1)(c) of the Health Research Council Act 1990
- is registered (number 00008713) with the US Department of Health and Human Services' Office for Human Research Protection (OHRP).

List of members

Name	*Category*	*Appointed*	*Term Expires*
Mrs Helen Walker	Lay (consumer/community perspectives)	19/08/2020	19/08/2021
Dr Pauline Boyles	Lay (consumer/community perspectives)	05/07/2019	05/07/2022
Dr Paul Chin	Non-lay (intervention studies)	27/10/2018	27/10/2021
Mr Dominic Fitchett	Lay (the law)	05/07/2019	05/07/2022
Dr Sarah Gunningham	Lay (other)	05/07/2016	05/07/2022
Assc Prof Mira Harrison-Woolrych	Non-lay (intervention studies)	28/06/2019	28/06/2020
Professor Jean Hay-Smith	Non-lay (health/disability service provision)	31/10/2018	31/10/2021
Dr Devonie Waaka	Non-lay (intervention studies)	18/07/2016	18/07/2019

Unless members resign, vacate or are removed from their office, every member of HDEC shall continue in office until their successor comes into office (HDEC Terms of Reference)

http://www.ethics.health.govt.nz

Appendix 2. Consent Forms for Phase 1, 2, and 3

Centre for Public Health Research, publichealth.massey.ac.nz
E: g.faeamani@massey.ac.nz
T: 0212171935
A: Massey University, Wellington Campus, PO Box 756, Wellington 6140
Courier Address Block 3, Level D, Entrance B Wallace St, Wellington 6021

Lifestyle Programme for Pacific Peoples

PARTICIPANT CONSENT FORM – CITIZENS PANEL (Phase 1)

- I have read or have had read to me in my first language the Information Sheet outlining the study.
- I have had the details of the study explained to me, and my questions have been answered to my satisfaction.
- I understand that I may ask further questions at any time.
- I have been given sufficient time to consider whether to participate in this study.
- I understand participation is voluntary and that I may withdraw from the study at any time.
- I understand that I have an obligation to respect the privacy of the other members of the group by not disclosing any personal information that they share during our discussion.
- I understand all Citizens Panel activities and discussion will be documented, audio recorded, and transcribed.
- I understand that I will be reminded again of the use of digital recorder before discussion commence.
- I understand all Citizens Panel data collected including audio recordings will be kept for 10 years before it will be destroyed.
- I understand that due to the nature of the research, I cannot ask for any already collected information to be withdrawn if you decide to pull out of the study.
- I understand that all the information I provide will be kept confidential to the extent permitted by law, and the names of all people in the study will be kept confidential by the researcher.

Note: There are limits on confidentiality as there are no formal sanctions on other group participants from disclosing your involvement, identity or what you say to others in the Citizens Panel. There are risks in taking part in this research and taking part assumes that you are willing to assume those risks.

I agree to participate in the Citizens Panel under the conditions set out in the Participant Information Sheet attached.

Declaration by Participant:

I _____ [print full name]_____ hereby consent to take part in this study.

Age_____, Year of Birth_____

Signature: _____ Date: _____

Centre for Public Health Research, publichealth.massey.ac.nz
E: g.faeamani@massey.ac.nz
T: 0212171935
A: Massey University, Wellington Campus, PO Box 756, Wellington 6140
Courier Address Block 3, Level D, Entrance B Wallace St, Wellington 6021

Lifestyle Programme for Pacific Peoples

PARTICIPANT CONSENT FORM – INTERVENTION (Phase 2) AND EVALUATION (Phase 3)

- I have read or have had read to me in my first language the Information Sheet outlining the study.
- I have had the details of the study explained to me, and my questions have been answered to my satisfaction.
- I understand that I may ask further questions at any time.
- I have been given sufficient time to consider whether to participate in this study
- I understand the focus group activities and discussion will be documented, audio recorded, and transcribed.
- I understand that I will be reminded again of the use of digital recorder before discussion commence.
- I understand all focus group data collected including audio recordings will be kept for 10 years before it will be destroyed.
- I understand participation is voluntary and that I may withdraw from the study at any time.
- I understand that if I
- I understand that I have an obligation to respect the privacy of the other members of the group by not disclosing any personal information that they share during our discussion.
- I understand that all the information I provide will be kept confidential to the extent permitted by law, and the names of all people in the study will be kept confidential by the researcher.

Note: There are limits on confidentiality as there are no formal sanctions on other group participants from disclosing your involvement, identity or what you say to others in the during the Intervention or Evaluation. There are risks in taking part in this research and taking part assumes that you are willing to assume those risks.

I agree to participate in the Intervention and Evaluation under the conditions set out in the Participant Information Sheet attached.

Declaration by Participant:

I _____ [print full name]_____ hereby consent to take part in this study.

Age:_____, Year of Birth:_____

Signature: _____ Date: _____

Appendix 3. Participants Information Sheet for Phase 1

Centre for Public Health Research, publichealth.massey.ac.nz
E: g.faeaman@massey.ac.nz
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A: Massey University, Wellington Campus, PO Box 756, Wellington 6140
Courier Address Block 3, Level D, Entrance B Wallace St, Wellington 6021

Lifestyle Programme for Pacific Peoples

PARTICIPANTS INFORMATION SHEET – CITIZENS PANEL (Phase 1)

Name of Researchers

- Dr Ridvan Firestone, Centre for Public Health, Massey University
- Dr Sunia Foliaki, Centre for Public Health, Massey University
- Assoc. Prof Nia Aitaoto, Department of Nutrition and Integrative Physiology, University of Utah

You are invited to take part in this project: 'Lifestyle Programme for Pacific Peoples'. This project is the subject of my PhD in Public Health, which is being undertaken through Massey University.

This Participant Information Sheet will help you decide if you would like to take part. It sets out why we are doing the study; what your participation would involve; what the benefits and risk to you might be; and what would happen after the study ends. We will go through this information with you and answer any questions you may have. We expect this will take about 15 minutes. You may also want to talk about the study with other people, such as family, friends, community, church, or health service providers. Feel free to do this.

If you agree to take part in this study, you will be asked to sign the Consent Form on the last page of this document. You will be given a copy of both the Participant Information Sheet and the Consent Form to keep.

We need your help to take part in Phase 1 of our study, to further our understanding of developing a culturally relevant intervention to help reduce the risk factors of cardiovascular disease (CVD) and type 2 diabetes (e.g. prediabetes, obesity, physical inactivity), among Tongan people.

Why are we doing the study?
CVD has a major impact on the health of NZ Pacific peoples. The purpose of this research is aimed at the prevention of CVD risk by tailoring an established programme to reduce these known risk factors. The primary objective of the study is to examine the effects of a culturally adapted diabetes prevention lifestyle programme in participants who have prediabetes and other CVD risk factors, among Tongan peoples.

Phase 1 of our study requires you to be part of a Citizen Panel. There will be 3 panels made up of Tongan community members and a health and research experts. The study phase is unique, because you will take an active role in adapting and establishing a Tongan culturally centered lifestyle programme to reduce CVD.

What your involvement will be:
Three Citizens' Panels are required for this study to adapt the Diabetes Prevention Programme (DPP) and Prevention of Type 2 Diabetes (PT2) to a culturally relevant programme that will reduce diabetes and CVD rates among Tongan people. Each Citizen's Panel will consist of 15 participants, where the first Citizen's Panel will include members of the community, the second Citizens Panel will be made up of health professionals, and the third Citizen's Panel will be a mixture of the first and second Citizen's Panel. The participants in the Citizens Panel will meet, discuss, and make decisions on how to adjust the DPP and PT2 in order to develop the New Zealand Lifestyle Program for Pacific (NZPLP).

You will be invited to participate in one of these Citizens Panel:

1. Community Panel – 1st & 3rd Panels
2. Expert Representatives – 2nd & 3rd Panels

What happens at the Citizen Panel meetings?
There will be a whole and small-group discussions at each panel meeting. Each panel meeting will be 4 hours long and breaks for refreshments. Your knowledge, perspectives and experiences on Pacific lifestyle habits and behavior's will make important and valued contributions at these meetings.

Each panel meeting will develop a list of questions and potential solutions for the next panel meeting to discuss and contribute ideas. The 3rd panel meeting will consist of representatives from the 1st and 3rd panel groups to finalize the details of the newly adapted lifestyle intervention programme. Talanoa principles will be used to consult in achieving a group agreement and identify questions for the next panel to consider.

All Citizens Panel activities and discussion will be documented, audio recorded, and transcribed. The audio recordings will not be masked and, no potential identifying information be redacted from the taps and transcription as it's a true reflection of the data, however for publication, format names and places will be deidentified. Participation is voluntary and that you may ask for the audio recorder to be stopped at any time during the interview or you can withdraw from the study at any time. All Citizens Panel data collected including audio recordings will be kept for 10 years before it will be destroyed.

What are your rights in the study?
You have the right to:

- Decline to answer any question
- Withdraw from the study at any time prior to the data analysis stage
- Ask any questions about the study at any time
- Provide information on the understanding that your name will not be used unless you give permission to the researcher
- Be given access to a summary of the research findings when it is concluded
- Ask for the digital recorder to be turned off at any time during the viewing time

What will happen after the study ends, or if you pull out?
The information you give us will be made confidential and stored away in a locked cabinet at the Centre for Public Health Research, for a period of 10 years, before it is destroyed, and will only be viewed by the named researchers. No individual, names, or information will be published that may lead to your identification.

Where can you go for more information regarding the study, or to raise concerns or complaints?
If you have any questions, concerns, or complaints about the study at any stage, please contact:

Mr Gavin Faeamani (PhD Candidate)
Contact number: 0212171945
Email: g.faeamani@massey.ac.nz

Dr Ridvan Firestone (Supervisor)
Contact number: +64 4 9793107
Email: r.t.firestone@massey.ac.nz

Appendix 4. Participants Information Sheet for Phase 2 & 3

Centre for Public Health Research, publichealth.massey.ac.nz
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Courier Address Block 3, Level D, Entrance B Wallace St, Wellington 6021

Lifestyle Programme for Pacific Peoples

PARTICIPATION INFORMATION SHEET
INTERVENTION (Phase 2) & EVALUATION (Phase 3)

Name of Researchers

- Dr Ridvan Firestone, Centre for Public Health, Massey University
- Dr Sunia Foliaki, Centre for Public Health, Massey University
- Assoc. Prof Nia Aitaoto, Department of Nutrition and Integrative Physiology, University of Utah

You are invited to take part in this project: 'Lifestyle Programme for Pacific'. This project is the subject of my PhD in Public Health, which is being undertaken through Massey University.

This Participant Information Sheet will help you decide if you would like to take part. It sets out why we are doing the study; what your participation would involve; what the benefits and risk to you might be; and what would happen after the study ends. We will go through this information with you and answer any questions you may have. We expect this will take about 15 minutes. You may also want to talk about the study with other people, such as family, friends, community, church, or health service providers. Feel free to do this.

Eligibility

To be eligible for this study, you will need to:

- self-identify as being Tongan;
- age between 18+ years;
- BMI>24;
  (Body Mass Index (BMI) is a measurement of a person's weight with respect to height and is calculated as BMI = (Weight in kilograms) divided by (Height in metres squared). A BMI of less than 18.5 is categorized as "underweight", 18.5 – 24.9 is "healthy or normal weight", 25.0 – 29.9 is overweight, and a BMI of 30 plus is categorized as "obese". Weight categorized as overweight and obese are associated with various health risks such as high blood cholesterol, type 2 diabetes, heart disease, stroke, high blood pressure, etc.)
- have had a recent blood test (in the last 12 months) in the prediabetes range that includes one of the following: non-fasting HbA1c blood test: 42 to 47 mmol/mol (6.0 to 6.4%); or a Fasting plasma glucose: 100–125 mg/dL; or a Two-hour plasma glucose (after a 75 gm glucose load): 140–199 mg/dL; or have received a result of high risk for type 2 diabetes on the Prediabetes Risk Test.

If you agree to take part in this study, you will be asked to sign the Consent Form on the last page of this document. You will be given a copy of both the Participant Information Sheet and the Consent Form to keep. We need your help, to further our understanding of developing a culturally relevant intervention to help reduce the burden of risk and prevent premature death from CVD risk and T2DM, among our Tongan people.

Why are we doing the study?

The purpose of this research is aimed at the prevention of CVD risk by tailoring an established programme to reduce these known risk factors. The primary objective of the study is to examine the effects of a culturally adapted diabetes prevention lifestyle programme in participants who have prediabetes and other CVD risk factors, among Tongan peoples.

If you are eligible, you will be invited to participate in Phase 2 of the study, which is the NZ Pacific Lifestyle Programme. You will also be asked to take part in Phase 3, where you will contribute to evaluating of the programme. This study is unique, because you will take an active role in participating and experiencing a Tongan culturally centered lifestyle change programme to reduce CVD risks, and the evaluation of the programme.

Intervention (Phase 2)

What your involvement will be:

Participating in this study consists of three stages.

Stage 1 involves collecting baseline data from you such as:

- Social demographics (age, ethnicity, NZ v Island born, deprivation)
- Past and family history of diabetes, CVD risk.
- Lifestyle factors: physical activity frequency, smoking history; a dietary diversity questionnaire of the last 7 days as an assessment of dietary intake
- Current medications (e.g. weight inducing medications)

Clinical CVD Markers

- Blood pressure
- Anthropometric measurements - body weight (kg), height (cm), BMI, waist and neck girth
- Recent blood test results using HbA1c levels that provides evidence of your eligibility (see above)
- Physical Functioning based on the 6MWT
- Quality of Life (QOL) using SF-36 instrument at pre and post intervention.

For Stage 2 and 3, you will be provided with more information once the intervention programme has been established by the Citizens Panel in Phase 1

Stage 2 is the weight loss intensity programme – where you begin the weekly physical and educational lifestyle programme, 2 hours every week with a 10 minutes break for refreshments, for 6 months.

Stage 3 is the weight loss maintenance programme – where you will attend monthly meetings, 1 hour with 10-minute break for refreshment per month, for 6 months to complete the NZPLP.

Evaluation (Phase 3)

What your involvement will be:

After the intervention, you will be invited to participate in one of the two focus groups, either (1) those who successfully completed the intervention programme (NZ Pacific Lifestyle Programme - NZPLP), or (2) those who did not. These focus group will discuss, evaluate, and examine; successful processes for engaging the participants; benefits and practical applications of the intervention; behavioural, cultural, and motivational drivers of change; quality of life; costs and sustainability of the intervention programme; and whether this intervention programme can be replicated in other communities (e.g. Māori). The focus groups are 2 hours each with a 10 minutes break for refreshments.

All Focus Group activities and discussion will be documented, audio recorded, and transcribed. The audio recordings will not be masked and, no potential identifying information be redacted from the taps and transcription as it's a true reflection of the data, however for publication, format names and places will be deidentified. Participation is voluntary and that you may ask for the audio recorder to be stopped at any time during the interview or you can withdraw from the study at any time. All Citizens Panel data collected including audio recordings will be kept for 10 years before it will be destroyed.

Note – If you were injured in this study, you are eligible to apply to ACC for compensation just as you would be if you were injured in an accident at work or at home. It does not mean your claim will automatically be accepted. You will have to lodge a claim with ACC, which may take some time to assess. If your claim is accepted, you will receive funding to assist in your recovery.

What are your rights in the study?

You have the right to:

- Decline to answer any particular question
- Withdraw from the study at any time prior to the data analysis stage
- Ask any questions about the study at any time
- Provide information on the understanding that your name will not be used unless you give permission to the researcher
- Be given access to a summary of the research findings when it is concluded
- Ask for the digital recorder to be turned off at any time during the viewing time

What will happen after the study ends, or if you pull out?
The information you give us will be made confidential and stored away in a locked cabinet at the CPHR, for a period of 10 years before it is destroyed, and will only be viewed by the named researchers. No individual or names will be published or that will lead to your identification. However, due to the focus group research, you cannot ask for any already collected information to be withdrawn if you decide to pull out of the study.

Summary of possible risk and benefits of participation
Participants will have the opportunity to contribute to the development of a healthy lifestyle programme that could provide benefits to their wellbeing and that of their communities. We do not foresee any major direct risks to the participants from taking part in the study. Our previous experience has shown that people are very keen to participate in our research when it is known that new knowledge could lead to benefitting themselves, family members and the wider community, as a process of capacity development. In particular, the participants in this study will be actively involved in adapting an established intervention (Diabetes Prevention Programme) with culturally relevant strategies to reduce diabetes risk among Pacific peoples. Since this study will have a very strong cultural focus, the benefits will outweigh the risks, because the project will be culturally appropriate, safe, and community led, which will be more acceptable.

Where can you go for more information regarding the study, or to raise concerns or complaints?
If you have any questions, concerns, or complaints about the study at any stage, please contact:

Mr Gavin Faeamani (PhD Candidate)
Contact number: 0212171945
Email: g.faeamani@massey.ac.nz

Dr Ridvan Firestone (Supervisor)
Contact number: +64 4 9793107
Email: r.t.firestone@massey.ac.nz

Appendix 5. Participants Demographic Information Sheet

SIA TOO'ONGA MO'UI DIABETES PREVENTION PROGRAMME (STM-DPP)

PARTICIPANT INFORMATION

ID:	
FIRST NAME:	**LAST NAME:**
GENDER: ○ Male ○ Female	**ADDRESS:**
AGE:	
EMAIL:	**POST CODE:**
MOBILE:	**ETHNICITY:**
HOME:	**BORN:** ○ NZ ○ Tonga ○ Other
MARITAL STATUS: ○ Married ○ Divorced ○ Widowed ○ Single, Never Married	**TOTAL HOUSEHOLD:** Adults: Children (Age under 18): **LANGUAGE SPOKEN AT HOME:** ○ English ○ Tongan ○ Other_____

1. HOW DID YOU HEAR ABOUT THIS PROGRAMME? Please tick one

1. ❑ Health Professional who is NOT my Regular Doctor
2. ❑ Regular Doctor
3. ❑ Primary Care Provider
4. ❑ Community Organization or Community Health Worker
5. ❑ Self – I decided to come on my own
6. ❑ Family / Friends
7. ❑ Employer or Employer Wellness Program
8. ❑ My local church
9. ❑ Media (Circle all that apply):

Radio	Banner	Facebook
Newspaper	Flyer	Instagram
Newsletter	Poster	Website

2. WHAT LEVEL OF EDUCATION HAVE YOU COMPLETED?

1. ❑ Primary School (Y1 – Y6)
2. ❑ Intermediate (Y7 – Y8)
3. ❑ High School (between Y9 – Y13)
4. ❑ Diploma/Trade Certificate
5. ❑ Degree

6. ❑ Master/PhD
7. ❑ Other_____

3. YOUR MOTIVATION TO PARTICIPATE?

1. ❑ Control of Health
2. ❑ Important
3. ❑ Set a good example
4. ❑ Treat body with respect
5. ❑ For myself and family

4. WHAT IS YOUR EMPLOYMENT STATUS?

1. ❑ Unemployed
2. ❑ Employed Full-time
3. ❑ Employed Part-time
4. ❑ Self-employed
5. ❑ Retired/Pension

5. DO YOU ATEEND CHURCH?

❑ No ❑ Yes _____

If Yes, in a typical week, how many days do you attend church or church activities?
_____ days

6. DO YOU HAVE A REGULAR DOCTOR?

❑ No ❑ Yes

7. DO YOU HAVE A REGULAR CLINIC THAT YOU GO FOR YOUR HEALTH NEEDS?

❑ No ❑ Yes

8. STRESS: IN A TYPICAL WEEK, HOW MANY DAYS DO YOU FEEL OVERWHELMED AND STRESS

_____ days

9. WHAT ARE THE BEST DAY/S TO ATTEND THIS 1-HOUR ZOOM CLASS? (Circle only maximum of 2 days)

- Monday
- Tuesday
- Wednesday
- Thursday
- Friday

10. THE ZOOM CLASS WILL MOST LIKELY BE IN THE EVENING. Circle only one of the times that suits you.

- 5pm – 6pm
- 6pm – 7pm
- 7pm – 8pm

- 8pm – 9pm

11. PERCEIVED HEALTH STATUS

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

12. DIAGNOSED HEALTH CONDITIONS

1. ❑ Diabetes
2. ❑ High Blood Pressure
3. ❑ Stroke
4. ❑ Cardiovascular disease
5. ❑ Lung
6. ❑ Athritis
7. ❑ Depression and/or anxiety
8. ❑ Others_____

13. FAMILY HISTORY OF DIABETES

(a) Do your parents/children/brothers/sisters have diabetes?

❑ Yes ❑ No

14. ARE YOU ON CURRENT MEDICATION

❑ Yes ❑ No If Yes, what are they?

(a) _____ (f)_____

(b)_____ (g)_____

(c)_____ (h)_____

(d)_____ (i)_____

(e)_____ (j)_____

CHALLENGES & SUPPORT FOR RETENTION

This is a 6 month program and will meet almost every week for the first 3 months and once a month for the last 3 months. You can make up classes.

15. How confident (sure) are you that you can do this for 6 months? (Check only one)

1. ❑ Very confident
2. ❑ Somewhat (“kind of”) confident
3. ❑ Not confident

16. YOU ARE CONFIDENT (SURE) THAT YOU CAN MAKE IT TO:

1. ❑ All or most (all but 1-5 classes)
2. ❑ More than half of the classes but not all/most
3. ❑ Less than half of the classes
4. ❑ None or almost none of the classes

17. WHAT WOULD MAKE IT HARD FOR YOU TO DO THIS FOR 6 MONTHS? (Tick all that apply)

1. ❑ 6 months is too long
2. ❑ Location of class
3. ❑ No or limited transportation
4. ❑ No time – other family, church, village and work commitments
5. ❑ No support
6. ❑ No laptop or mobile
6. ❑ Other:

_____

18. WHAT WILL HELP YOU KEEP COMING BACK TO CLASS? (Add comments if you like under "Other")

1. ❑ Weekly Reminders
2. ❑ Coming with a friend
3. ❑ Class flexibility (ex. change schedule for holidays and community events)
4. ❑ Supportive and Trustworthy Lifestyle Coach
5. ❑ Supportive Class Participants
6. ❑ Transportation
7. ❑ Childcare
8. ❑ Other: _____

19. WHAT SUPPORT DO YOU NEED TO MAKE HEALTHY LIFESTYLE CHANGE?

(Please rank items 1-6. Or you can check "None" or "Not sure." Add comments if you like under "Other"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Encouragement, Spiritual & Emotional support					
Family/Friends/Co-workers eating healthy & exercising together					
Family buying & cooking healthy foods					
Church/Work/Community serving healthy foods at group events					
Access to fruits & vegetables					

Access to places to exercise (walk, run, etc.)					

❑ You don't need support.
❑ You're not sure what support you need.
❑ Other support that you need: _____

20. PHYSICAL ACTIVITY:

1. In a typical week, how many days do you exercise enough to break a sweat or breathe heavily (like running or walking, gardening or cleaning house, Zumba) _____ days
2. On the day(s) you exercise, about how many minutes are you physically active? _____ minutes

21. NUTRITION:

1. In a typical week, how many days do you eat vegetables?
_____ days
2. On the day(s) you eat vegetables, how many servings do you usually eat?
_____ servings
3. In a typical week, how many days do you eat fruit?
_____ days
4. On the day(s) you eat fruit, how many servings do you usually eat?
_____ servings
5. In a typical week, how many days do you eat fatty or fried foods?
_____ days
6. On the days you eat fatty/fried foods, how many servings do you usually eat?
_____ servings
7. In a typical week, how many days do you drink sugar sweetened beverages (SSBs)? _____ days
8. On the day(s) you drink SSBs, how many servings do you usually drink? _____ cups or _____ can

Appendix 6. Prediabetes Risk Test (PDRT)

Prediabetes Risk Test

NATIONAL DIABETES PREVENTION PROGRAM

1. How old are you?

Write your score in the boxes below

Younger than 40 years (0 points)
40–49 years (1 point)
50–59 years (2 points)
60 years or older (3 points)

2. Are you a man or a woman?

Man (1 point) Woman (0 points)

3. If you are a woman, have you ever been diagnosed with gestational diabetes?

Yes (1 point) No (0 points)

4. Do you have a mother, father, sister, or brother with diabetes?

Yes (1 point) No (0 points)

5. Have you ever been diagnosed with high blood pressure?

Yes (1 point) No (0 points)

6. Are you physically active?

Yes (0 points) No (1 point)

7. What is your weight category?

(See chart at right)

Total score:

Height (cm)	Weight (kg)		
147	54 - 64	65 - 86	87+
150	56 - 66	67 - 89	90+
152	58 - 69	70 - 92	93+
155	60 - 71	72 - 95	96+
158	62 - 74	75 - 98	99+
160	64 - 76	77 - 102	103+
163	66 - 78	79 - 104	105+
165	68 - 81	82 - 108	109+
168	70 - 84	85 - 111	112+
170	72 - 86	87 - 115	116+
173	74 - 89	90 - 118	119+
175	77 - 91	92 - 122	123+
178	79 - 94	95 - 125	126+
180	81 - 97	98 - 129	130+
183	84 - 99	100 - 133	134+
185	86 - 102	103 - 136	137+
188	88 - 105	106 - 140	141+
190	91 - 108	109 - 144	145+
193	93 - 111	112 - 148	149+
	1 Point	2 Points	3 Points
4	*You weigh less than the 1 Point column (0 points)*		

Adapted from Bang et al., Ann Intern Med 151:775-783, 2009. Original algorithm was validated without gestational diabetes as part of the model.

If you scored 5 or higher

You are at increased risk for having prediabetes and are at high risk for type 2 diabetes. However, only your doctor can tell for sure if you have type 2 diabetes or prediabetes, a condition in which blood sugar levels are higher than normal but not high enough yet to be diagnosed as type 2 diabetes. **Talk to your doctor to see if additional testing is needed.**

If you are African American, Hispanic/Latino American, American Indian/Alaska Native, Asian American, or Pacific Islander, you are at higher risk for prediabetes and type 2 diabetes. Also, if you are Asian American, you are at increased risk for type 2 diabetes at a lower weight (about 6.8 kg lower than weights in the 1 Point column). Talk to your doctor to see if you should have your blood sugar tested.

You can reduce your risk for type 2 diabetes

Find out how you can reverse prediabetes and prevent or delay type 2 diabetes through a **CDC-recognized lifestyle change program** at https://www.cdc.gov/diabetes/prevention/lifestyle-program.

CS300699-A

American Diabetes Association.

Appendix 7. Diet Diversity Questionnaire

ID_____

FAMILY DIABETES INTERVENTION PROGRAMME
DIET DIVERSITY QUESTIONNAIRE

In this section, we are interested in the 'range' of food that you may be eating. Please consider all the foods that you have eaten over the last seven (7) days (5 week and 2 weekend days).

1) **Group 1: meat, poultry, fish diversity**	Yes	No
[1]Lamb or mutton (flaps, chops, leg, stewing meat, etc.)	☐	☐
[2]Beef (steak, mince, stewing meat, etc.)	☐	☐
[3]Pork (chops, fillet, leg, etc.)	☐	☐
[4]Hocks, pork bones, pig's head	☐	☐
[5]Other meats e.g. venison, horse	☐	☐
[6]Goat (meat)	☐	☐
[7]Offal (liver, kidney, heart, etc)	☐	☐
[8]Cured meat (povi masima, ham, bacon)	☐	☐
[9] Tinned meat (corn-beef)	☐	☐
[10]Sausage, all varieties	☐	☐
[11]Luncheon meat, all varieties	☐	☐
[12]Fish, fresh, white (Hoki, snapper)	☐	☐
[13]Fish, fresh, brown or pink (salmon, trout, eel)	☐	☐
[14]Tinned fish (tuna or salmon)	☐	☐
[15]Other tinned fish (sardines, mackerel, herring)	☐	☐
[16]Roe (kina)	☐	☐
[17]Shell fish (mussels, paua, oysters, pipis, cockles, scallops, etc)	☐	☐
[18]Crayfish, shrimp, prawns, crab	☐	☐
[19]Squid, calamari, octopus	☐	☐
[20]Whitebait	☐	☐

[21]Chicken (whole, thighs, drumsticks)		
[22]Chicken nibbles or chicken wings		
[23]Chicken offal (e.g. livers, hearts, giblets, chicken frames)		
[24]Other poultry (turkey, duck, mutton bird, etc.)		
[25]Crumbed or battered chicken, fish or beef (nuggets, cutlets, fingers, sticks)		
[26]Eggs		
[27]Other		

2) **Group 2: Dairy products diversity**	Yes	No
[1]Full cream milk (pasteurised) (dark blue top)		
[2]Low-fat milk (pasteurised) (light blue top)		
[3]Skim milk (pasteurized) (green or yellow top)		
[4]UHT milk, boxed		
[5]Evaporated milk, tinned, (unsweetened)		
[6]Condensed milk		
[7]Milk powder		
[8] Hard cheese (tasty, edam, cheddar etc.)		
[9]Soft cheese (cottage, cream cheese, ricotta, etc.)		
[10]Processed cheese (slices or spread)		
[11]Custard		
[12]Ice cream		
[13] Yoghurt		
[14] Dairyfood		
[15]Buttermilk		
[16]Cream or sour cream		
[17]Soy milk		
[18] Other		

3) **Group 3: bread, cereals and starchy vegetable diversity**	Yes	No
[1]Rice, all varieties including long grain, basmati, coco rice, etc.	☐	☐
[2]Bread (white or brown) (toast or sandwich)	☐	☐
[3]Bread rolls, any type (white or brown)	☐	☐
[4]Bread, high fibre or whole wheat, all varieties	☐	☐
[5]Speciality breads (croissant, panini, focaccia, pita, wraps, etc.)	☐	☐
[6]Maori bread, doughboys	☐	☐
[7]Fruit bread or hot cross buns	☐	☐
[8]Rice vermicelli (rice noodles)	☐	☐
[9]Instant noodles (two-minute noodles, all varieties)	☐	☐
[10]Instant flavoured pasta packets (macaroni cheese, chicken mushroom)	☐	☐
[11]Pasta (spaghetti, macaroni)	☐	☐
[12]Speciality starchy foods (couscous, quinoa, bulgar wheat)	☐	☐
[13]Dumpling (pork dumpling or red bean dumpling)	☐	☐
[14]Muffins (savoury e.g. cheese)	☐	☐
[15]Scones (savoury e.g. cheese or fruity e.g. date)	☐	☐
[16]Crackers (Cream Crackers, Vita Wheat)	☐	☐
[17]Porridge (rolled oats, oat meal)	☐	☐
[18]Sweetened breakfast cereals (coco pops, fruit loops, Milo cereal)	☐	☐
[19]Unsweetened breakfast cereals (cornflakes, rice bubbles, Special K)	☐	☐
[20]Bran flakes (All Bran, Fruitfull bran, Special K Advantage)	☐	☐
[21]Weet-bix	☐	☐
[22]Muesli, all varieties	☐	☐
[23]Liquid meals (Up-and-Go, Primo)	☐	☐
[24]Taro	☐	☐
[25]Cassava	☐	☐
[26]Green banana	☐	☐

[27]Potatoes	☐	☐
[28]Sweet potatoes	☐	☐
[29]Corn	☐	☐
[30]Turnip	☐	☐
[31]Yams	☐	☐
[32]Other	☐	☐

4) **Group 4: legume and nut diversity**	Yes	No
[1]Dried legumes (all varieties dried beans, peas, lentils, soup mixes)	☐	☐
[2]Canned beans, all varieties	☐	☐
[3]Chick peas, canned	☐	☐
[4]Coconut flesh	☐	☐
[5]Nuts (e.g. pecan, walnut, almond, cashew)	☐	☐
[6]Peanuts	☐	☐
[7]Salted, flavoured nuts	☐	☐
[8]Seeds (e.g. sunflower, sesame, poppy)	☐	☐
[9]Other	☐	☐

5) **Group 5: fruit diversity**	Yes	No
[1]Apple	☐	☐
[2]Peaches, white	☐	☐
[3]Peaches, yellow	☐	☐
[4]Apricots	☐	☐
[5]Mango	☐	☐
[6]Pears	☐	☐
[7]Grapes (black/green)	☐	☐
[8]Plum	☐	☐
[9]Lemon, lime	☐	☐
[10]Orange	☐	☐

[11]Mandarin		
[12]Banana		
[13]Pineapple		
[14]Avocado		
[15]Berries (blueberry, blackberry, raspberry) and cherries		
[16]Strawberry		
[17]Kiwifruit		
[18]Gooseberry		
[19]Watermelon		
[20]Melon, green or yellow		
[21]Persimmon		
[22]Guava		
[23]Lychees		
[24]Papaya/pawpaw		
[25]Tamarilo/tree tomato		
[26]Passion fruit		
[27]Prunes, dates		
[28]Raisins, sultanas, currants		
[19]Feijoa		
[20]Other		
6) **Group 6: vegetable diversity**	Yes	No
[1]Onions		
[2]Spring onions		
[3]Leeks		
[4]Cabbage		
[5]Red cabbage		
[6]Spinach, silverbeet		

[7]Puha		
[8]Watercress		
[9]Rhubarb		
[10]Beetroot		
[11]Chinese greens (bok choy, pak choi)		
[12]Brussel sprouts		
[13]Taro leaves		
[14]Carrots		
[15]Parnsnip		
[18]Radishes		
[19]Asparagus		
[20]Celery		
[21]Cucumber		
[22]Gem-squash		
[23]Pumpkin		
[24]Butternut		
[25]Tomatoes		
[26]Green beans (fresh)		
[27]Peas (fresh – green)		
[28]Cauliflower		
[29]Broccoli		
[30]Chilli (red/green)		
[31]Lettuce, all varieties		
[32]Mushroom		
[33]Courgette/zucchini		
[34]Capsicum (green, yellow, orange, black)		
[35]Capsicum, red		

[36]Eggplant/aubergine		
[37]Sweet-corn (yellow)		
[38]Garlic		
[39]Other		

7) **Group 7: oil and fat diversity**	Yes	No
[1]Butter		
[2]Clarified butter (ghee)		
[3]Margarine		
[4]Margarine, low fat or lite		
[5]Lard (e.g. dripping, animal fat)		
[6]Oil (olive, sunflower, canola, rice bran)		
[7]Coconut cream (Kara, Fia Fia, Palm)		
[8]Coconut milk (Kara, Ayam, Tropical)		
[9]Other		

8) **Group 8: drinks diversity**	Yes	No
[1]Juice (100% pure fruit juice e.g. Ceres, Arano, V8 vegetable juices)		
[2]Juice (<100% pure / imitation juice, e.g. Just Juice, McCoy)		
[3]Imitation drinks (cordial, raro)		
[4]Soft drinks (Coke, Fanta.)		
[5]Flavoured milk (Milo, Nesquik, Primo, hot chocolate, milkshakes, ice coffee)		
[6]Tea (Dilma, Twinings)		
[7]Herbel tea (green tea, chamomile.)		
[8]Coffee, instant or brewed, with or without milk (flat white, espresso)		
[9]Coffee,–based drinks (latte, cappuccino, mochaccino)		
[10]Soups, instant		
[11]Energy drinks (Red Bull, Mother)		

[12]Sports drinks (Powerade, Gatorade)	☐	☐
[13]KoKo	☐	☐
[14]Instant soups	☐	☐
[15]Other	☐	☐

9) **Group 9: alcohol diversity**	Yes	No
[1]Beer	☐	☐
[2]Home brewed beer (Hop beer, aaleve)	☐	☐
[3]Cider (Monteiths crushed apple, Magners)	☐	☐
[4]Wine (red or white)	☐	☐
[5]Spirits (rum, brandy, whiskey)	☐	☐
[6]Kava	☐	☐
[7]RTDs - ready to drink mixers (Vodka Cruiser, Jim Beam, Archers)	☐	☐
[8]Other	☐	☐

10) **Group 10: sauces, spreads and flavouring diversity**	Yes	No
[1]Tomato, mustard, BBQ, sweet chilli sauce, etc	☐	☐
[2]Mayonnaise, salad cream or creamy dressings (aioli, tartare)	☐	☐
[3]Salad dressing (French, Italian)	☐	☐
[4]Chutney, relish	☐	☐
[5]White sauce, cheese sauce	☐	☐
[6]Gravy, homemade (thickened with Bisto)	☐	☐
[7]Gravy, packet (Maggi roast chicken gravy, Royal brown gravy, pepper sauce)	☐	☐
[8]Soy sauce	☐	☐
[9]Fish sauce/paste	☐	☐
[10]Salt, added to food or drink	☐	☐
[11]Sugar, white or brown, added to food or drink (on cereal, in drinks)	☐	☐
[12]Jam, marmalade	☐	☐

[13]Peanut butter	☐	☐
[14]Honey	☐	☐
[15]Chocolate spread (Nutella)	☐	☐
[16]Syrup (golden, maple)	☐	☐
[17]Yeast spreads (Marmite, Vegemite)	☐	☐
[18]Cheese spreads (Kraft cheese spread, etc.)	☐	☐
[19]Dips	☐	☐
[20]Hummus	☐	☐
[21]Pate	☐	☐
[22]Other	☐	☐

11) **Group 11: sweets and sweet snacks diversity**	Yes	No
[1]Chewing gum	☐	☐
[2]Chocolates	☐	☐
[3]Lollies	☐	☐
[4]Cakes (fruit loaves, chocolate muffin, carrot cake)	☐	☐
[5] Sweet bakery items (e.g. slices, pastries, tartlets,doughnuts)	☐	☐
[6]Plain biscuits (superwines, milk arrowroot)	☐	☐
[7]Fancy biscuits (tim tams, toffee pops, swiggles, chocolate chip)	☐	☐
[8]Pancakes, pikelets, waffles	☐	☐
[9]Desserts and puddings (mousse, bread and butter pudding)	☐	☐
[10]Jelly	☐	☐
[11]Ice blocks	☐	☐
[12]Other	☐	☐

51)Group 12: savoury snacks diversity	Yes	No
[1]Chips/crisps	☐	☐
[2]Orange cheese puffs (Twisties, Cheezels, Rashuns)	☐	☐

[3]Corn chips (Doritos)	☐	☐
[4]Pretzels	☐	☐
[5]Popcorn	☐	☐
[6]Savoury bakery items (small sausage roll, quiche)	☐	☐
[7]Prepackaged bars (Muesli, Nut, Cereal bars)	☐	☐
[8]Crackers (rice crackers, crispbread, cheese crackers)	☐	☐
[9]Bhuja mix	☐	☐
[10]Other	☐	☐

52) **Group 13: take away food diversity**	Yes	No
[1]Pizza (Domino's, Hell's)	☐	☐
[2]Hamburgers (Burger King, Burger Fuel, McDonalds, Fish & Chip)	☐	☐
[3]Hot chips, French fries, Kumara chips	☐	☐
[4]Battered fish	☐	☐
[5]Pies, sausage rolls	☐	☐
[6]Sandwiches, wraps, pitas (Subway, Pita pit, Turkish kebab)	☐	☐
[7]Sushi	☐	☐
[8]Battered hot dogs	☐	☐
[9]Fried Chicken (Kentucky, Country Fried, etc.)	☐	☐
[10]Noodle canteen	☐	☐
[11]Indian	☐	☐
[12]Thai	☐	☐
[12]Chinese	☐	☐
[13]Other	☐	☐

EATING HABITS

53) How would you describe your appetite? *Tick one option*

Good:
Being able to eat and enjoy moderate sized meals without difficulty
and being able to snack in-between meals

Fair:
Being able to eat moderate sized meals, but finding it hard to complete meals, and seldom snacking in-between meals

Poor:
Never feeling like eating OR being hungry but don't feel like eating food at all AND generally not enjoying eating at all.

Appendix 8. Clinical Markers

SIA TOO'ONGA MO'UI DIABETES PREVENTION PROGRAMME

CLINICAL MARKERS

ID :_____

NAME:_____

AGE :_____

DATE :_____

1. WEIGHT: _____KG
2. HEIGHT : _____CM
3. WAIST : _____CM
4. SELF-REPORTED HbA1c _____
5. BLOOD PRESSURE: SYS :_____

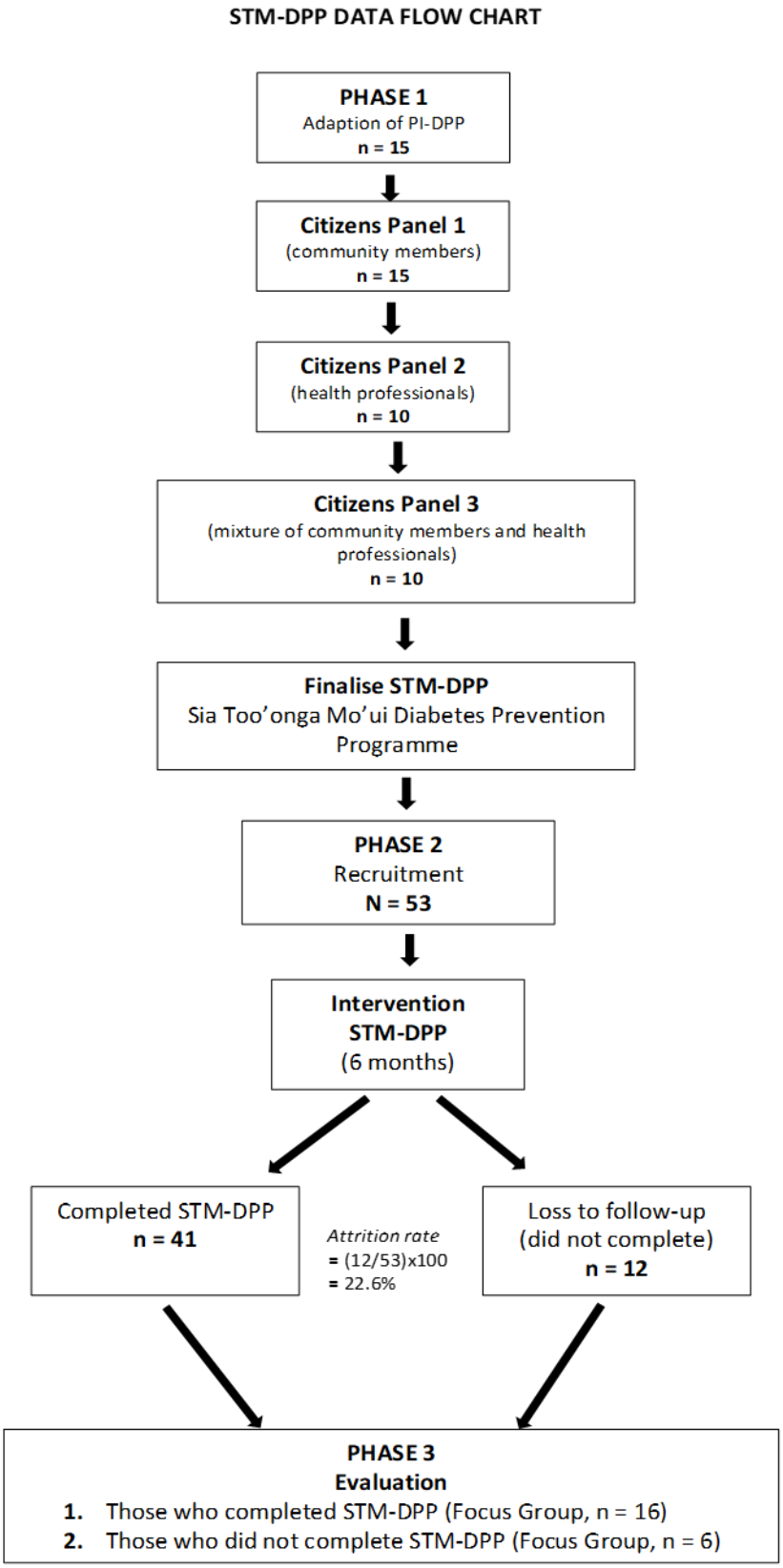
   DIA :_____

   PULSE:_____
6. 6MWT (Six Minute Walk Test) = _____M

Appendix 9. Sia Too'onga Mo'ui Diabetes Prevention Programme (STM – DPP)

Data Collection	WEST AUCKLAND	SOUTH AUCKLAND	Notes
#1 – Baseline data collection	16th Wed, June 2021, 6pm – 8.30pm Massey Leisure Center 545 Don Buck Road Massey	17th Thur, June 2021 6pm – 8.30pm Siasi Tonga Tau'ataina, 47 Favona, Mangere	Refreshments provided
ZOOM MEETINGS			
Date & Time	**Modules**		
June			
30th Wednesday, 7pm – 8pm	**1**	Introduction to Sia To'onga Mo'ui Diabetes Prevention Programe (STM-DPP)	
July			
7th Wednesday, 7pm – 8pm	**2**	Get Active	
14th Wednesday, 7pm – 8pm	**3**	Track your Physical Activity	
21st Wednesday, 7pm – 8pm	**4**	Eat well	
28th Wednesday, 7pm – 8pm	**5**	Track your food	
August			
4th Wednesday, 7pm – 8pm	**6**	Tongan starch foods & what to do at Tongan feasts and cultural functions	
11th Wednesday, 7pm – 8pm	**7**	Burn Calories more than you take in	
18th Wednesday, 7pm – 8pm	**8 & 9**	Get more active & managing stress	
25th Wednesday, 7pm – 8pm	**10 &11**	Find time for fitness & coping with triggers	
September			
1st Wednesday, 7pm – 8pm	**12**	Keep your heart healthy	
8th Wednesday, 7pm – 8pm	**13 & 14**	Shop and cook to prevent diabetes & getting support	
15th Wednesday, 7pm – 8pm (Measurements only)	**WEST AUCK**	**FOLLOWUP #1 - Weight & Blood Pressure (Massey Leisure Center)**	
16th Thursday, 7pm – 8pm (Measurements only)	**SOUTH AUCK**	**FOLLOWUP #1 - Weight & Blood Pressure (STT, Favona)**	
22nd Wednesday, 7pm – 8pm	**15 & 16**	Take charge of your thoughts & eating well away from home	
29th Wednesday, 7pm – 8pm	**17 & 18**	Stay motivated to prevent diabetes & how to deal when weight loss stalls	
October			
6th Wednesday, 7pm – 8pm	**19**	Stay active	
20th Wednesday, 7pm – 8pm	**20**	More about diabetes	
November			
3rd Wednesday, 7pm – 8pm	**21**	Take a fitness break	
17th Wednesday, 7pm – 8pm	**22**	Get enough sleep	
December			
1st Wednesday, 7pm – 8pm	**23**	**PREVENT DIABETES FOR LIFE**	
7th Tuesday, 7pm – 8pm FINAL MEASUREMENTS	**SOUTH AUCK**	**FOLLOWUP #2 – Weight, Blood Pressure (STT, Favona)**	
8th Wednesday, 7pm – 8pm FINAL MEASUREMENTS	**WEST AUCK**	**FOLLOWUP #2 – Weight, Blood Pressure (Massey Leisure Center)**	
9th Thursday, 7pm – 8.30pm	**FAVONA**	**PRIZE GIVING & DINNER**	

Appendix 10. STM-DPP FLOW CHART



Appendix 11. Flyer 1 (Registration Information)

Appendix 12. Flyer 2 (Goals)

GOAL

ZOOM SESSION START

Wednesday 30th June

START TODAY

- Improve diet and lifestyle
- Exercise 30minutes per day or Total of 150 minutes per week

AFTER 6 MONTHS

- Should loose 5% or more of your original body weight

PREVENT OR SLOW THE PROGESS OF DIABETES

Appendix 13. Exploratory Factor Analysis

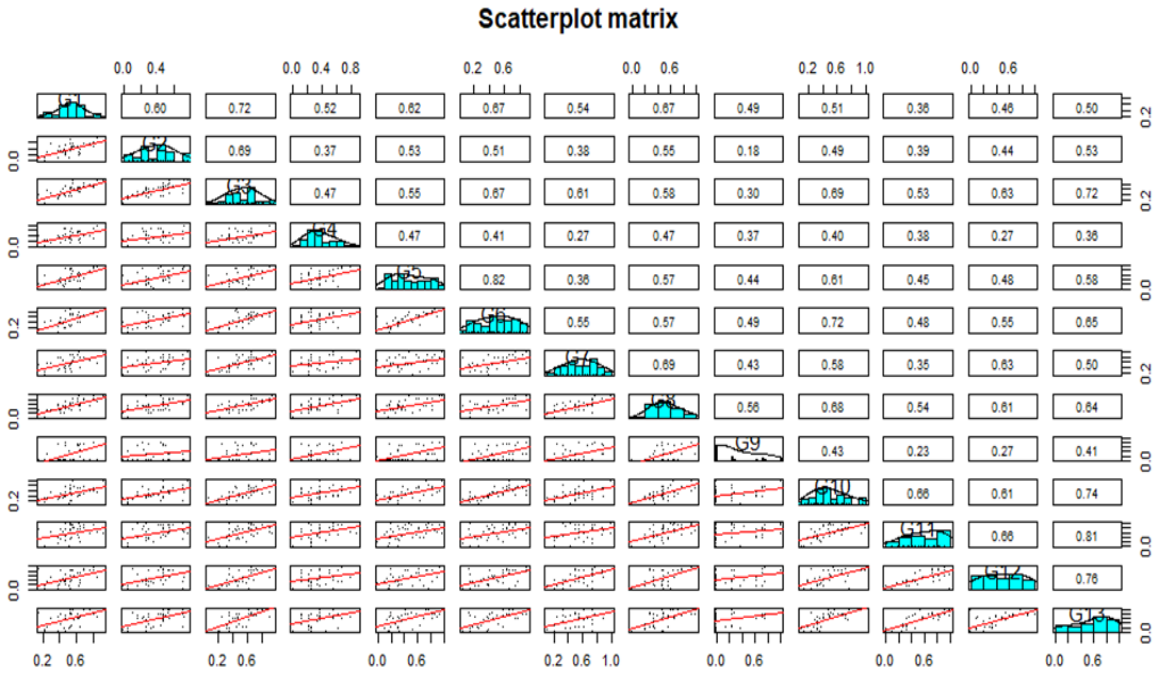
The file Diet01.csv was then imported in R and converted into a R-readable file named "Diet.RData". The R code containing all the instructions for reading the file "Diet.RData" and computations for the Diet diversity analysis is contained in file "Diet diversity analysis.R". In the remaining descriptions, I will briefly describe what particular groups of lines (commands) in the R-code do, the outcome produced by those commands and, when required, an interpretation of the results. All the lines starting with the # symbol are comments. In the R-code, just before crucial calculations, an explanation is given.

Lines	Description
2	Reading the psych package. This package contains special procedures for Exploratory Factor Analysis (EFA); the name of the package stands for "psychology". It is a general purpose toolbox in R for personality, psychometric theory and experimental psychologyanalyses.
3	Reading "Diet.RData"
4-16	Creating 13 data frames (sub-data bases, readable in R), according to the diet group. These data frames contain ID, SITE, GENDER, and 0-1 data
17-29	The key part for EFA. These commands produce 13 new variables containing the proportion of times a person answered "Yes" in each diet group. This proportion will act as the response variable. EFA will analyze 13 response variables, each variable representing a proportion of positive answer in the diet group.
30	Putting the 13 variables together in a single data frame (Groups)
53	Summary statistics calculations for all 13 variables
55-56	Displaying Pearson's correlations between all pairs of variables, numerically and graphically.
59-60	Boxplots of Proportions for each Diet group.
62-64	Testing multivariate normality of the 13 variables in two different ways. EFA is a suitable analysis only when the data "passes" the assumption of multivariate normality. In our case, our data passed the Mardia test!
66-78	EFA is only useful when a remarkable intercorrelation of all variables is present. The larger the number of correlated variables, the better. These lines produce, first, a spider web plot connecting all diet groups with correlations larger than 0.3. It was found that 92.3% of all possible diet pairs have correlations of 0.3 or larger.
79-81	EFA is doubtful if there is multicollinearity among variables (one or more variables are simply multiples of others). The determinant of the correlation matrix must be larger than 0. This holds for our correlation matrix thus, there is no multicollinearity.
82-87	EFA is useful only when the items (diet groups in our case) share common variance, expressed in the correlation matrix. The Kaiser-Meyer-Olkin factor adequacy is a statistic that measures the adequacy of our sampled data. For acceptability, values ≥ .70 will be preferred. In our case, all variables have MSA larger than 0.7. Thus, the correlation matrix is adequate for EFA.
89-92	Running Bartlett's test of sphericity. Sphericity means that none of the variables are correlated. Thus, another way to support the suitability of EFA is to reject

	that the correlation matrix is the trivial identity matrix. This was so for our diet data.
93-101	An “exaggerated” EFA assuming a big number of factors (6 in this case), explaining the data. This is the beginning of the model selection of our factor analysis. Model selection means that we will choose the EFA with an appropriate number of factors explaining the data. Theoretically, as many factors as measured variables (13) can be extracted. However, parsimony often suggests that most of the variance can be accounted for by only a few factors, for example, where two factors are sufficient to account for the majority of variance in 13 variables. This EFA with six factors was only run in order to start exploring possible anomalies in the data; it will be ignored.
106-112	The number of factors to be kept in EFA can be determined using different methods. It is not convenient to determine the number of factors to be retained using only one method. In these lines, two methods are applied: a scree plot and a parallel analysis. The conclusion using these two methods is that one factor must be retained.
113-152	Another method of factors selection is “Minimum average partial” or MAP. In our data, the MAP value remains equal for the first two factors (0.52) and then increases to 0.66. The lowest MAP value identifies the number of factors to retain. In this case, MAP reaches a minimum at two factors. Therefore, two factors must be retained. After a thorough discussion written on lines 119-152, about the suitability of EFA for our data and the appropriate number of factors that will be used, it was concluded that an EFA with two factors will be enough. However, to “double-check” this decision, a 3-factor EFA was also ran. Another computational issue in our EFA is the method of oblique rotation to be implemented. In our case, promax was chosen because it is an oblique modification of the widely accepted varimax procedure. In addition, the estimation method for the factors was Maximum Likelihood.
154-169	3-factor EFA. The results of the 3-factor EFA follow. This listing corresponds to the first part of the results file I sent you before (pages 1-2)

(a) Testing for Linearity

	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13
G1	1.0000000	0.5963934	0.7247656	0.5222799	0.6166276	0.6672652	0.5355290	0.6733132	0.4863735	0.5072325	0.3648343	0.4616374	0.5041740
G2	0.5963934	1.0000000	0.6883842	0.3664189	0.5274635	0.5146111	0.3771451	0.5496906	0.1759910	0.4931921	0.3858912	0.4356110	0.5302681
G3	0.7247656	0.6883842	1.0000000	0.4739071	0.5467373	0.6730904	0.6100013	0.5757611	0.2953417	0.6884157	0.5307253	0.6313210	0.7230696
G4	0.5222799	0.3664189	0.4739071	1.0000000	0.4650268	0.4139572	0.2743368	0.4701141	0.3746616	0.4032313	0.3791024	0.2693168	0.3622807
G5	0.6166276	0.5274635	0.5467373	0.4650268	1.0000000	0.8162220	0.3550848	0.5693127	0.4363388	0.6098992	0.4508990	0.4750294	0.5777166
G6	0.6672652	0.5146111	0.6730904	0.4139572	0.8162220	1.0000000	0.5458289	0.5679942	0.4878542	0.7203770	0.4839442	0.5500862	0.6475292
G7	0.5355290	0.3771451	0.6100013	0.2743368	0.3550848	0.5458289	1.0000000	0.6854046	0.4326275	0.5811528	0.3515251	0.6303379	0.5049353
G8	0.6733132	0.5496906	0.5757611	0.4701141	0.5693127	0.5679942	0.6854046	1.0000000	0.5568170	0.6796005	0.5444498	0.6137314	0.6443986
G9	0.4863735	0.1759910	0.2953417	0.3746616	0.4363388	0.4878542	0.4326275	0.5568170	1.0000000	0.4302495	0.2344860	0.2742879	0.4071335
G10	0.5072325	0.4931921	0.6884157	0.4032313	0.6098992	0.7203770	0.5811528	0.6796005	0.4302495	1.0000000	0.6628470	0.6090907	0.7421474
G11	0.3648343	0.3858912	0.5307253	0.3791024	0.4508990	0.4839442	0.3515251	0.5444498	0.2344860	0.6628470	1.0000000	0.6642459	0.8139972
G12	0.4616374	0.4356110	0.6313210	0.2693168	0.4750294	0.5500862	0.6303379	0.6137314	0.2742879	0.6090907	0.6642459	1.0000000	0.7564795
G13	0.5041740	0.5302681	0.7230696	0.3622807	0.5777166	0.6475292	0.5049353	0.6443986	0.4071335	0.7421474	0.8139972	0.7564795	1.0000000



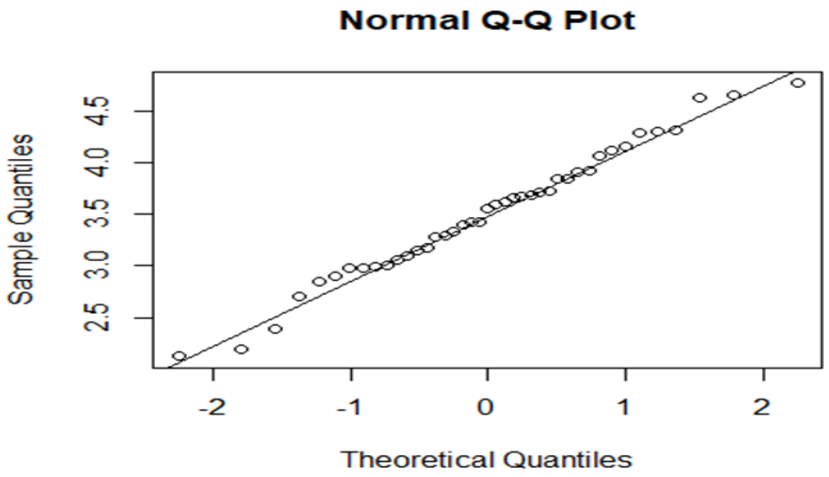
The Pearson correlation coefficient (r) is the most common way of measuring a linear correlation. It is a number between –1 and 1 that measures the strength and direction of the relationship between two variables. When one variable changes, the other variable changes in the same direction. The Pearson correlation shows strong positive relations between food groups.

(b) Testing for Multivariate Normality

Testing multivariate normality of the 13 food groups can be done in two different ways. EFA is a suitable analysis only when the data "passes" the assumption of multivariate normality. The skewness is similar to the expected skewness in a multivariate normal. The data passed the Mardia test for skewness.

```
> mardia(Groups, plot=T)
Call: mardia(x = Groups, plot = T)

Mardia tests of multivariate skew and kurtosis
Use describe(x) the to get univariate tests
n.obs = 41   num.vars =  13
b1p =  59.41   skew =  405.94  with probability  <=  0.95
small sample skew =  440.13  with probability   <=  0.68
b2p =  180.13   kurtosis =  -2.41  with probability <=  0.016

> mult.norm(Groups)
$mult.test
              Beta-hat     kappa           p-val
Skewness  59.40589    405.940228   0.95218675
Kurtosis    180.12902  -2.410844      0.01591566

$Dsq
 [1] 22.736953  9.950152    21.445642  13.835788 21.661687    8.888427   15.241844
11.533957
 [9] 15.372554  10.868833  16.938460  7.282041    4.495945     13.437340  13.793333
16.493411
[17] 10.050340  8.932016   13.617156   11.750402 14.776423   12.665678   8.847013
13.090490
[25] 18.460494  9.547149   18.330914   17.288161  9.313303     13.428130  14.767777
11.085911
[33]  4.831709   11.717161  8.407423    9.009067    12.919603  5.730214     10.739096
18.597843
[41]  8.120160

$CriticalDsq
[1] 29.81947
```

In addition, the Normal Q-Q Plot shows that quantiles of the observed multivariate data are close to the expected theoretical quantiles in a multivariate normal distribution.



(c) Testing for Multicollinearity

```
> det(cor(Groups))
[1] 1.558918e-05
```

EFA is useful only when the food groups share common variance, expressed in the correlation matrix. The Kaiser-Meyer-Olkin factor adequacy is a statistic that measures the adequacy of our sampled data. For acceptability, values ≥ .70 will be preferred. In our case, all variables have MSA larger than 0.7. Thus, the correlation matrix is adequate for EFA.

```
> KMO(Groups)
Kaiser-Meyer-Olkin factor adequacy
Call: KMO(r = Groups)
Overall MSA =  0.84
MSA for each item =
  G1   G2   G3   G4   G5   G6   G7   G8   G9   G10  G11  G12  G13
0.84 0.89 0.80 0.87 0.86 0.85 0.81 0.82 0.80 0.89 0.83 0.91 0.84
```

Running Bartlett's test of sphericity (ref). Sphericity means that none of the variables are correlated. Thus, another way to support the suitability of EFA is to reject that the correlation matrix is the trivial identity matrix. This was so for our food groups.

```
> cortest.bartlett(cor(Groups), n=41)
$chisq
[1] 385.5679
$p.value
[1] 3.046786e-42
$df
[1] 78
```

Appendix 14. Exploratory Factor Analysis with 3 factors(Baseline)

Data Entry and Importation into R

The Diet Diversity data was collected and entered; imported into R; and converted into a R-readable file named "Diet.RData". The R code containing all the instructions for reading the file "Diet.RData" and computations for the Diet diversity analysis is contained in file "Diet diversity analysis.R"

Reading "Diet.RData"

Creating 13 data frames (sub-data bases, readable in R), according to the diet group. These data frames contain ID, SITE, GENDER, and 0-1 data.

To ensure both practical (10% variance explained) and statistical significance (p < .05) of pattern loadings, the threshold for salience will be set at $\frac{3.92}{\sqrt{N-2}} = \frac{3.92}{\sqrt{41-2}} = \mathbf{0.628}$ (Norman & Streiner, 2014) with a goal of approximate simple structure.

```
> print(f3, digits=3, sort=TRUE)
Factor Analysis using method =  ml
Call: fa(r = Groups, nfactors = 3, n.obs = 41, rotate = "promax", residuals = TRUE,
   SMC = TRUE, missing = FALSE, fm = "ml")
```

Standardized loadings (pattern matrix) based upon correlation matrix

	item	ML3	ML2	ML1	h2	u2	com
G5	5	**1.029**	0.010	-0.256	0.768	0.2322	1.12
G6	6	**0.843**	0.022	0.040	0.789	0.2108	1.01
G1	1	**0.785**	-0.150	0.163	0.644	0.3564	1.16
G4	4	0.596	0.027	-0.090	0.309	0.6908	1.05
G2	2	0.557	0.167	-0.041	0.432	0.5684	1.19
G9	9	0.459	-0.098	0.222	0.319	0.6809	1.55
G3	3	0.395	0.310	0.210	0.673	0.3267	2.47
G11	11	-0.077	**1.036**	-0.181	0.769	0.2310	1.07
G13	13	0.088	**0.927**	-0.061	0.904	0.0964	1.03
G12	12	-0.110	**0.660**	0.333	0.694	0.3065	1.54
G10	10	0.329	0.458	0.137	0.697	0.3029	2.02
G7	7	-0.154	-0.097	**1.156**	0.995	0.0050	1.05
G8	8	0.298	0.201	0.406	0.656	0.3442	2.36

The root mean square of the residuals (RMSR) is **0.054 ≤ 0.08**

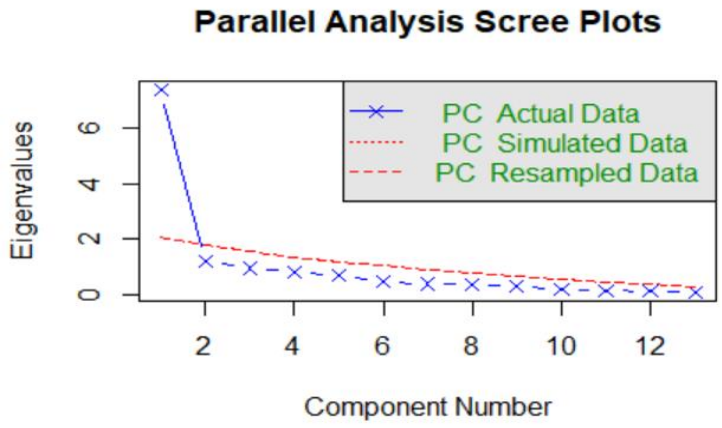
```
> print(residls3)
   G1    G2    G3    G4    G5    G6    G7    G8    G9   G10   G11   G12
G1     NA
G2   0.09    NA
G3   0.12  0.17    NA
G4   0.09  0.01  0.06    NA
G5  -0.05 -0.03 -0.07 -0.02    NA
G6  -0.04 -0.06 -0.02 -0.07  0.06    NA
G7   0.00  0.00  0.00  0.00  0.00  0.00    NA
G8   0.08  0.06 -0.08  0.09  0.01 -0.09  0.00    NA
G9   0.04 -0.17 -0.14  0.08 -0.01  0.00  0.00  0.12    NA
G10 -0.07 -0.03  0.01 -0.01  0.00  0.04  0.00  0.03  0.01    NA
G11  0.00 -0.04 -0.04  0.08  0.00 -0.01  0.00  0.03 -0.03  0.03    NA
G12  0.00  0.00  0.00 -0.05  0.03  0.00  0.00  0.00 -0.07 -0.05  0.01    NA
G13 -0.01  0.00  0.02 -0.03  0.00  0.00  0.00  0.00  0.04 -0.01  0.00  0.00
```

BIC = -98.995

There is a symptom of model misfit due to overfactoring (why?). There is one factor with only one (singlet) salient loadings. Such factor is relatively weak and unlikely to replicate. This is the case with Factor 3.

<u>Conclusion: a three-factor model is too excessive.</u>

Another explanation that a 3-factor is not suitable is based on Cronbach's alpha: alpha is not computable for the third factor having only one variable (G7). 2-factor EFA. The results of the 2-factor EFA follow. This listing corresponds to the second part of the results file I sent you before (pages 1-2)



Appendix 15 (a). Questions for the Citizens Panel 1

Sia Tō'onga Mo'ui Study

Phase 1 - Adapting and Developing the Sia Tō'onga Mo'ui Programme

Citizens Panel 1 Questions

(COMMUNITY MEMBERS)

1. What do you think about the PI-DPP programme?

2. Can we adapt this PI-DPP programme?

3. How can we adapt the PI-DPP?

4. What would enable people to participate in the programme or what would make people commit or stay for the full duration of the programme?

5. What do you think about the modules? How would you adjust these modules to fit our culture and the way we live here in NZ?

6. How would you deliver this adapted DPP?

7. What approach would you use to deliver this adapted DPP?

8. What sort of incentives are there apart from financials?

9. What are barriers that may prevent you from participating or discourage you from participating for the full duration of the programme.

Appendix 15 (b). Questions for the Citizens Panel 2

Sia Tō'onga Mo'ui Study

Phase 1 - Adapting and Developing the Sia Tō'onga Mo'ui Programme

Citizens Panel 2 Questions

(HEALTH EXPERT REPRESENTATIVES)

1. Present the findings and recommendations from Citizens Panel 1 in how to tailoring the program and curriculum modules

2. What do you think about the PI-DPP programme?

3. Can we adapt this PI-DPP programme?

4. How can we adapt the PI-DPP?

5. What would enable people to participate in the programme or what would make people commit or stay for the full duration of the programme?

6. What do you think about the modules? How would you adjust these modules to fit our culture and the way we live here in NZ?

7. How would you deliver this adapted DPP?

8. What approach would you use to deliver this adapted DPP?

9. What sort of incentives are there apart from financials?

10. What are barriers that may prevent you from participating or discourage you from participating for the full duration of the programme.

Appendix 15 (c). Questions for the Citizens Panel 3

Sia Tō'onga Mo'ui Study

Phase 1 - Adapting and Developing the Sia Tō'onga Mo'ui Programme

Citizens Panel 3 Questions

(REPRESENTATIVES FROM CITIZENS PANEL 1 & 2)

1. Present the findings and recommendations from Citizens Panel 2 in how to tailor the program and curriculum modules

2. How can you adapt PI-DPP and ensure that it suit the Tongan people and community to a NZ context?

3. How can you ensure that the adapted programme is culturally appropriate to the NZ Tongan context?

4. How would you deliver this adapted DPP?

5. What approach would you use to deliver this adapted DPP?

6. What sort of incentives would you provide?

7. How can you provide access to the programme?

Appendix 16. Characteristics of Citizens Panel 1

Citizens Panel 1			
Characteristics	**Male n(%)**	**Female n(%)**	**Total**
Gender	7 (46.6)	8 (53.3)	15
Age, mean (SD)	36.0 (11.27)	50.0 (8.24)	42.5 (12.04)
Profession			
Church Minister	2 (100.0)	-	2
Construction	1 (100.0)	-	1
Correction Officer	1 (100.0)	-	1
Dental Assistant	-	1 (100.0)	1
Firefighter	1 (100.0)	-	1
General Manager	-	1 (100.0)	1
Logistics & Freight	-	1 (100.0)	1
Nurse	-	1 (100.0)	1
Restaurant Manager	-	1 (100.0)	1
Security	1 (100.0)	-	1
Social Worker	1 (50.0)	1 (50.0)	2
Tertiary Student	-	2 (100.0)	2
Church			
Free Church of Tonga	4 (80.0)	1 (20.0)	5
Methodist	2 (40.0)	3 (60.0)	5
Seventh Day Adventist	1 (20.0)	4 (80.0)	5
Born in Tonga			
Yes	7 (50.0)	7 (50.0)	14
No	-	1 (100.0)	1
Marital Status			
Divorced	-	1 (100.0)	1
Married	7 (58.3)	5 (41.6)	12
Single-Never married	-	2 (100.0)	2

Appendix 17. Characteristics of Citizens Panel 2

Citizens Panel 2			
Characteristics	**Male n(%)**	**Female n(%)**	**Total**
Gender	4 (40.0)	6 (60.0)	10
Age, mean (SD)	48.7 (8.46)	49.33(9.70)	49.1 (8.73)
Profession			
Medical Dr - General Practice	-	2 (100.0)	2
Medical Dr - Public Health Researcher	-	1 (100.0)	1
PhD. Dietician/Diabetes Specialist	-	1 (100.0)	1
PhD. Nutritionist	-	1 (100.0)	1
PhD. Public Health	1 (100.0)	-	1
Nurse	-	1 (100.0)	1
PhD. Accountant	1 (100.0)	-	1
PhD. Education	1 (100.0)	-	1
Tertiary Student	1 (100.0)	-	1
Church			
Free Church of Tonga	1 (50.0)	1 (50.0)	2
LDS	-	1 (100.0)	1
Methodist	4 (100.0)	-	4
Presbyterian	1 (100.0)	-	1
Seventh Day Adventist	-	1 (100.0)	1
Uniting Church	-	1 (100.0)	1
Born in Tonga			
Yes	4 (40.0)	6 (60.0)	10
No	-	-	-
Marital Status			
Divorced	-	-	-
Married	3 (33.3)	6 (66.6)	9
Single-Never married	1 (100.0)	-	1

Appendix 18. Characteristics of Citizens Panel 3

Citizens Panel 3			
Characteristics	**Male n (%)**	**Female n (%)**	**Total**
Gender	4 (40.0)	6 (60.0)	10
Age, mean (SD)	49.5 (9.94)	50.1 (9.57)	49.9 (9.17)
Profession			
Firefighter	1 (100.0)	-	1
Construction	1 (100.0)	-	1
Church Minister	1 (100.0)	-	1
PhD. Public Health	1 (100.0)	-	1
Social Worker	-	1 (100.0)	1
Medical Dr - Public Health Researcher	-	1 (100.0)	1
PhD. Nutritionist	-	1 (100.0)	1
PhD. Dietician/Diabetes Specialist	-	1 (100.0)	1
Nurse	-	1 (100.0)	1
Medical Dr - General Practice	-	1 (100.0)	1
Church			
Free Church of Tonga	3 (75.0)	1 (25.0)	4
Methodist	-	3 (100.0)	3
Presbyterian	-	1 (100.0)	1
Seventh Day Adventist	1 (100.0)	1 (100.0)	2
Born in Tonga			
Yes	8 (100.0)	-	8
No	-	2 (100.0)	2
Marital Status			
Divorced	-	-	-
Married	4 (40.0)	6 (60.0)	10
Single-Never married	-	-	-