The University of Auckland

The influences of health-related knowledge, attitudes and behaviours on the health and wellbeing of Rarotongan adolescents

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A thesis submitted in partial fulfilment of the requirements for the degree of Masters of Health Science, The University of Auckland, 2018.

Abstract

This baseline study aimed to examine the associations between anthropometric data and health-related knowledge, attitudes and behaviours (KAB) among Rarotongan Year 9 students, prior to participating in the Pacific Science for Health Literacy Project in 2016. A cross-sectional design was used to examine associations between anthropometric measures and health-related KAB data from 133 students.

Firstly, this study identified high rates of non-communicable disease (NCD) risk factors among the study participants: 64.4% were classified as overweight/obese, 58.1% were at risk of high blood pressure and 32.6% were centrally obese. In terms of the KAB data, students overall demonstrated a good level of knowledge regarding nutrition and had positive attitudes towards nutrition. However, their responses also demonstrated poor self-reported food and meal consumption patterns. Key results from the comparison between anthropometric and KAB data showed that obese and severely obese students were 2.7 times more likely to consume fizzy drinks nearly every day compared with healthy weight students ($p = 0.058$). Furthermore, students with raised blood pressure (BP) were 2.6 times less likely to eat fruit ($p = 0.010$) than students with normal BP. This highlights that students with anthropometric risk factors were more likely to have poorer dietary patterns. Interestingly, this study also found that overweight students were 2.6 times more likely to rate what they eat matters compared with their healthy weight counterparts ($p = 0.026$). Additionally, students with raised BP were 4.6 times more likely to strongly agree that it is important to eat healthy food now ($p = 0.020$). This shows that relationships were also found linking adolescents with anthropometric risk factors to healthy attitudes. Additionally, there were associations which did not show significant differences. This study acknowledges that while several associations show that KAB does impact the health of adolescents, there might also be several other factors affecting adolescent health status.

This study showed that NCD primary prevention programmes in the Cook Islands need to focus earlier in the life-course. The findings from this study may inform future research, programmes and policy, indicating that focusing on addressing adolescent health prior to becoming parents can help protect the health of the future generations essentially reducing the high burden of NCD in the Cook Islands.

Dedication

"Kua kite 'oki tātou ē, i roto i te au mea rava rāi tē 'akatupu nei te Atua i te meitaki nō te aronga tei 'inangaro atu i aia, ko tei kāpiki'ia kia tau ki tōna 'akakoro'anga" Roma 8:28

"And we know that all things work together for good to them that love God, to them who are the called according to his purpose"
Romans 8:28

This thesis is dedicated to my greatest supporters; my husband and family.

To my husband, Papamama Pokino, thank you for being my pillow when this journey stressed me out. Thank you for being there when I needed someone to talk to. Thank you for working to support us so that I could carry on with my study. Thank you for taking over my duty in our marriage so that I could stay late night and do my study. Thank you for encouraging me to keep going when I felt like giving up. But most of all, thank you for encouraging me not to fail God's ministry because as you say, "God first and everything else will fall into place".

To my parents, Tuakana and Maina Tairi, sisters, Tanya and Tumaru, brother in law, Pastor Papauri Pere and finally my niece and nephew, Lovannah and Leong. Thank you all for your continuous prayers, encouragements and support throughout my journey.

Acknowledgements

"E ma'ata rava atu tā te Atua rāvenga i te au mea katoa tā tātou e pati nei ē tā tātou e manako nei, nā roto i te mana e 'anga'anga nei i roto i a tātou"
Ephesia 3:20

"Now unto him, that is able to do exceeding abundantly above all that we ask or think, according to the power that worketh in us"
Ephesian 3:20

First and foremost, thank you Lord Jesus Christ, for your grace, mercy and never failing compassion upon me. Your words never failed to encourage me every day when I felt like throwing in the towel. Without you Lord, I would not have made it this far. Amen.

My sincere thanks go to my supervisors, Professor Mark Vickers and Doctor Jacquie Bay who have worked patiently with me to complete this thesis. I am overwhelmingly grateful for your time, efforts, guidance, encouragement and dedication.

I would also like to thank the partners involved in the Pacific Science for Health Literacy project: The Cook Islands Ministry of Health, the Cook Islands Ministry of Education and the Liggins Institute for recruiting me to take part in the project.

I would like to thank both the participants and their parents for taking part in this research. This study would not have been possible without your involvement.

I would like to thank the New Zealand Health Research Council for providing financial assistance that funded this study and provided further financial support that took care of my husband and me.

I would like to thank the Cook Islands Ministry of Health for funding the annual school health check which made it possible to collect the adolescent health profile used in this study. I would also like to thank the New Zealand Ministry of Foreign Affairs and Trade for funding the Pacific Science for Health Literacy project which enabled the collection of the health-related knowledge, attitudes and behaviour data.

I would like to thank Dr Neti Herman and Associate professor Vili Nosa for your support and encouragement that you have both given me throughout my academic life.

To Narlei Taufa, Eliza Puna, Siobhan Tua'koi, thank you for helping check my work, I am very grateful for your guy's help.

Also to Alvina Pauvale and Heimata Herman, we have started this journey together and have been through ups and down. I am very privileged to have met you two on this journey and the relationship that we built together encouraging and supporting each other.

To my churches, both the Rarotongan Apostolic church and the Auckland Apostolic Cornerstone church. Firstly my heartfelt thank you goes out to my Rarotonga Apostolic church, who showered us with lots of support and financial blessing prior to leaving the Cook Islands. Also want to thank my Auckland Apostolic Cornerstone church, who took care of my husband and me since the day we arrived. Thank you, both for your continuous prayers and support.

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Abbreviations

BMI	Body Mass Index
BP	Blood pressure
CIMOH	Cook Islands Ministry of Health
CIMOE	Cook Islands Ministry of Education
CVD	Cardiovascular diseases
CRT	Critical Realism Theory
DOHaD	Developmental Origins of Health and Disease
GDP	Gross domestic product
HICs	High-income countries
KAB	Knowledge, attitudes and behaviours
LDL	Low-density-lipoprotein
LMICs	Low- and middle-income countries
NCDs	Non-communicable diseases
PSHLP	Pacific Science for Health Literacy Project
SDH	Social Determinants of Health
SSB	Sugar-sweetened beverage
SD	Standard Deviation
TC	Total cholesterol
WHtR	Waist-to-height-ratio
WHO	World Health Organization

CHAPTER ONE: INTRODUCTION

Introduction

This chapter will provide an overview of the work detailed in this thesis. It starts by setting the scene on who the researcher is and how this research evolved. The next part explores the global non-communicable disease epidemic, along with its social and economic consequences. The third part reviews the overall theory underpinning this research – the Developmental Origins of Health and Disease framework. The fourth part presents the Cook Islands and youth demography therein. The fifth part outlines the research aims and objectives. This chapter concludes by describing the different chapters presented in this thesis.

Setting the scene

"Urau! Urau!
Turou! Turou!
E Enua Tupuna noku, mei po kerekere mai Enuamanu
E Ariki noku te noo I te itinga ra
Ko koe e Rongomatane Ariki
E ava noku ko Te Patiki enua ko Tarapaku
E marae ko Vairakaia
E vai umome ko Vai Inano
E patu paepae ko Teapiripiri
E vaka ko Pakipaki enua
E atamira ko Ai te puaioio
E tokotoko ko Te-puaioio o te Rangi
E matakeinanga ko Ngati Parua-rangi
Ko au teia e tu atu nei
E ina-rere na Rongomatane Ariki
Ie – e – e – ko – ko……"

"Hear ye! Hear !
Welcome! Welcome!
This is my ancestral land called Enuamanu
My queen is Rongomatane Ariki
My landing is Tarapaku
My sacred place is Vairakaia

My bathing place is Inano
My sitting place is Teapiripiri
My canoe is Pakipaki Enua
My chiefly seat is Ai te puaioio
My spear is Te-puaioio o te Rangi
My tribe is Ngati-Paruarangi
Today I stand here….
A great-granddaughter of Rongomatane, my paramount chief of Atiu Island
It is so…..It is so……"

Kia Orana and warm Pacific greetings, my name is Mayor Tairi Pokino. I am a young Cook Island woman, 29 years of age. I currently live in Auckland, New Zealand. My parent's names are Tuakana and Maina Tairi, and I have two siblings, Tanya and Tumaru. I was born and raised on the island of Atiu, which is one of the 15 islands in the Cook Islands, until I was 12 years old.

My family migrated to Rarotonga for further educational and other life opportunities. I attended Nikao Maori school (year 5 to year 8), and after that, I went to Tereora college (Year 9 to Year 13). After completing Tereora College, I moved to New Zealand to attend the University of Auckland.

My passion for addressing non-communicable diseases (NCDs) started when I witnessed my grandfather's health deteriorating. His name was Ina Teiotu, and he was diagnosed with co-morbidities including diabetes, hypertension, asthma and cardiovascular disease. In 2012, at the age of 67 years, he, passed away. His death was painful to deal with, and it was a dramatic adverse event for our family who not only lost a grandfather but a father too. This is one of the leading reason I was motivated to take on this research, to help reduce NCD in the Cook Islands.

In addition, my interest in NCDs among Pacific people was heightened during undergraduate studies. I learnt that there are vast ethnic disparities whereby Pacific/Maori people by far experience higher rates of NCD related morbidity and premature deaths. Seeing these facts really irritated me, and I started questioning why? Why are Pacific people suffering from high rates of NCD, yet it is a preventable disease. This further deepened my passion for finding solutions that can help reduce the burden of NCD among the Pacific community. In 2017, I was given an opportunity to complete a Master of Health Science through the Pacific Science for Health Literacy project (PSHLP). This project is a multi-sectoral empowerment-

based program, using a transformative learning model. The program (2012) was developed via a collaboration between the Cook Islands Ministries of Education and Health and the Liggins Institute at the University of Auckland. The PSHLP learning programmes support the development of scientific and health literacies thereby equiping students with the skills and knowledge that can enable and influence decision-making processes relevant to NCD risk reduction in the context of the Rarotongan population.

I am grateful for the opportunity given to undertake this research that allows me to fulfil my passion for serving my community. This opportunity not only allows me to make a difference for the Cook Islands people but also the broader Pacific Islands community.

The global non-communicable disease epidemic

Non-communicable diseases are medical conditions that are not contagious, but progresses slowly and last for a long period of time (Boutayeb, 2005). The four main groups of NCDs are (1) cardiovascular diseases (CVD), (2) cancers, (3) chronic respiratory diseases and (4) diabetes (World Health Organization, 2011). Although mental health conditions and neurological diseases are significant additional group, the literature predominantly refers to the four main areas when addressing issues around prevention and control of NCD (McNaughton et al., 2008).

NCD is the number one leading cause of death in the world. Annually, approximately 36 million people die from NCDs, representing 63% of all global deaths (World Health Organisation, 2013). Approximately 80% of these deaths occur within low- and middle-income countries (LMICs) (World Health Organization, 2011, 2012). 48% of NCD related deaths in these countries are occurring among people under the age of 70 years. This is twice the rate compared to high-income countries (HICs) (26%). The difference is even more marked for NCD deaths in the younger age range in LMICs where 29% of NCD deaths occur among people under the age of 60, compared to 13% in HICs (World Health Organization, 2012).

Two-third's of the world's premature NCD related deaths are associated with conditions or unhealthy behaviours that initiated during adolescence (World Health Organization, 2015a). These behaviours include, but are not limited to; unhealthy diet, physical inactivity, tobacco consumption and harmful use of alcohol (World Health Organisation, 2013). A life-course approach to NCD prevention suggest's that early-life interventions can lead to a more

significant reduction in NCD risks in adulthood (Gluckman & Hanson, 2006). Therefore, it is crucial that health policies and programs utilise preventive measures, earlier in the life-course, to reduce the overwhelming burden of NCDs (World Health Organisation, 2017).

Non-communicable Risk factors

NCD risks arise from both modifiable and non-modifiable factors. Modifiable factors can be changed by societies or an individual to improve health outcomes (Viner et al., 2012). Non-modifiable risk factors cannot be changed by societies or an individual, for example; various hereditary factors, sex or age (Bloom et al., 2011). Most NCDs are the accumulative result of modifiable factors, which lead to four central metabolic changes (raised blood pressure, overweight/obesity raised blood glucose and raised cholesterol) and essentially increasing the risk of developing NCDs (World Health Organization, 2011). Some of these modifiable factors are due to lifestyle choices that can be controlled and avoided, for example, unhealthy eating behaviours (Boutayeb, 2005). However, a myriad of interacting environmental, epigenetic and behavioural factors also contribute to NCD risk that is beyond the control of an individual (Vineis, Stringhini, & Porta, 2014). This indicates that NCD is caused by multiple factors, therefore the solutions need to be multifactorial.

The socioeconomic impacts of non-communicable diseases

The NCD epidemic is creating overwhelming social and economic burden throughout the world (Olsen et al., 2016). In 2011, it was projected that NCDs costed a global output loss of US$47 trillion and this represents 75% of the global GDP (Bloom et al., 2011). This impact is most noticeable in LMICs (World Health Organization, 2011), where it is projected to inflict US$21.3 trillion losses over the next two decades (Mitchell, Daniels, Thomas, Bollyky, & Tuttle, 2014). These losses are from costs associated with health care, reduced economic productivity and labour force (Beaglehole et al., 2011). The most prominent drivers of these losses are premature deaths and NCD related morbidity cases, and these burdens are substantially high in LMICs compared to other parts of the world (Xiaohui, Anderson, & Burton-Mckenzie, 2016).

In addition to the economic costs are the social impacts as a result of the high morbidity and premature death rates. This will mostly affect households who have members diagnosed with NCD as they will face increased demands and dependency. Often these roles are taken up by women and children (Arrossi et al., 2007). As a result, the children are forced to stay home

and miss school to care for their family members. The women may have to cut down on working hours to look after their loved ones (United Nation Development Programme, 2013). In addition, premature deaths of both parents and grandparents can result in orphanage situation, in particular for children with no family members or carers (Ellis, Dowrick, & Lloyd-Williams, 2013). In the Pacific, a more common scenario is the loss of caregiver role of the parents and grandparents. This indicates that the impact of NCD goes beyond health. Thus effective prevention and mitigation measures cannot be implemented by the health sector alone. Instead, they require multi-sectoral actions and collaborations from various sectors (e.g. economic and social sectors) to tackle NCD.

Developmental Origin of Health and Disease (DOHaD)

The Developmental Origin of Health and Disease (DOHaD) framework is a field of science that explores how the early life developmental period can impact disease risk in later life and future generations (Hanson & Gluckman, 2014). DOHaD is defined as below:

"environmental factors acting during the phase of developmental plasticity that interact with genotypic variation to change the capacity of the organism to cope with its environment in later life" (Hanson & Gluckman, 2014, p. 1027).

Evidence from DOHaD studies identified relationships between the early-life environment (e.g. maternal obesity, fetal growth restriction) and increased NCD risk during adulthood (Gluckman & Hanson, 2006; M. A. Hanson & Gluckman, 2014; Reddy & Mbewu, 2016; Roseboom, van der Meulen, Ravelli AC, Barker, & Bleker, 2001; Wadhwa, Buss, Entringer, & Swanson, 2009). Barker and colleagues (1986), for instance, observed that low birth weight was associated with a higher prevalence of hypertension, coronary heart disease, stroke and metabolic syndrome in adulthood (Barker, Forsén, Uutela, Osmond, & Eriksson, 2001; M. A. Hanson & Gluckman, 2014). Yang et al., (2010) observed that high birth weight predicted obesity in middle age. This suggests how the health and nutritional exposures of the mother over early phases from conception, pregnancy, birth to childhood impact the risks of developing NCDs later in life (a process preferentially termed "developmental programming") (Morton, 2006). Additionally, there is accumulating evidence suggesting a role for paternal factors (e.g. obesity in the father) in such early life developmental programming (Gluckman & Hanson, 2006). This programming is transgenerational in nature

with the disease traits transmitted to the next generation through either maternal or paternal lineage (Godfrey, Gluckman, & Hanson, 2010).

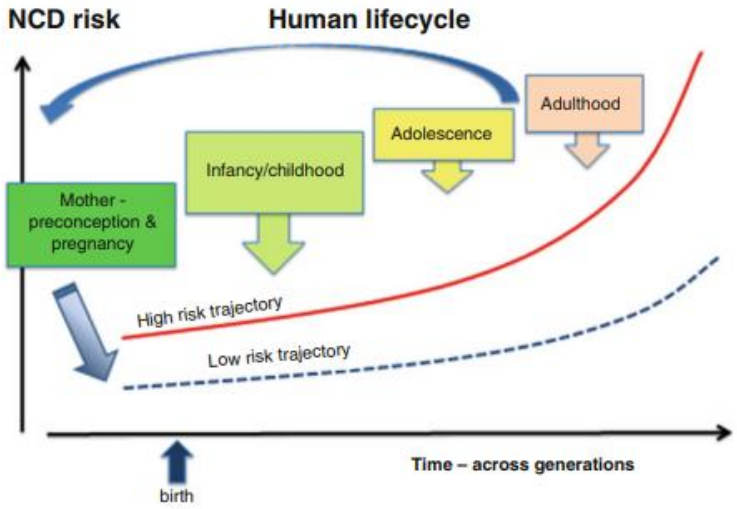


Figure 1: Developmental plasticity across the life course, timing of interventions and effect on disease risk (Hanson, 2016)

The DOHaD life course approach conveys that a healthy start to life reduces the risk of NCD and promote the development of healthy adults in the next generation (Baird et al., 2017). Figure 1 demonstrates how health-risks accumulates over the life course. It also highlights point's in life that are effective for primary prevention of NCD. Primary prevention refers to actions aimed at avoiding the onset of disease, for example, preserving good nutritional status (Puska & Keller, 2004). According to DOHaD, interventions targeting pregnancy and preconceptions are more effective at reducing the disease risk given that this is the period where the individual can be easily moulded or shaped compared to other life phases (plasticity). Later interventions during the adult phase do reduce the risk, but to a smaller degree compared to earlier strategies. While preconception and pregnancy period offer a much more efficient window of opportunity to intervene, but scientific evidence demonstrates that health and nutritional environment before this phase contributes to programming or conditioning of later health and diseases (Gluckman & Hanson, 2006). Addressing the health, social and environmental determinants before conception and in the periconceptional period is therefore very important (Gluckman, Hanson, Zimmet, & Forrester, 2011). This highlights the opportunity to intervene during adolescence as shown below (Figure 2).

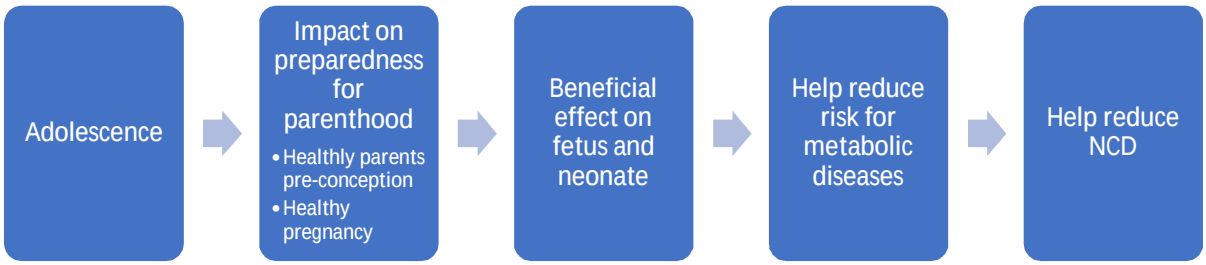


Figure 2: DOHaD pathways to NCD risk reduction

Adolescence is a crucial determining life phase for nutritional, physical activity and cognitive behaviours. Behaviours that starts during this life phase track through and becomes established during adulthood, in turn influencing future health outcomes (Craigie, Lake, Kelly, & Adamson, 2011). Adolescence is a period away from pregnancy. However, it is important to note that this term includes individuals from 10 to 19 years. The global average age of teenage pregnancy is around 15 to 19 years, so this study is mainly addressing adolescents age between 10 to 14 years. Although the majority of adolescents around this age group are not sexually active, it is also important to note that there is a significant number who do engage in sexual activities (World Health Organization, 2018). However, in the context of the Cook Islands, the 2011 Census highlighted that most teenage women who have given birth were between 17 to 19 years (18.1%) and is most prevalent on the island of Rarotonga. There were no teenage women that gave birth under 16 years (Cook Islands Ministry of Finance and Economic Management, 2012). The target age group in this study is between 12 to 14 years old, which means there is still a significant amount of time to influence their health behaviours prior to pregnancy. This age group holds the key to determining the nutritional, environmental exposures and health of the offspring. Although DOHaD theorises that these individuals already carry the disease trait due to the nutritional environment and health that they were exposed to during and before the fetus stage. Nevertheless, educating both male and female adolescents to adopt positive health, lifestyle and behaviours before becoming parents can help mitigate the risks from passing onto the next generation, therefore breaking the transgenerational cycle of NCD.

Why focus on the Cook Islands?

In the Cook Islands, relatively high rates of overweight and obesity are evident among children aged between 5 – 18 years. Between 2003 and 2015, overweight in children age 5 to 12 years old increased from 12.6% to 21.3%. In 13 – 18 years old it rose from 28.4% to 43.4%. In 2015, overweight/obesity in 18 to 24-year-olds was 87.2%/68.5% (Cook Islands Ministry of Health, 2016). Additionally, relatively high rates of poor dietary behaviours were found among children aged between 12 to 17 years old. The 2010 Cook Islands Global School Health Survey revealed that only 40.4% of children reported meeting the World Health Organization guideline for fruit and vegetable consumption of 5+ a day. A significant 60.2% reported consuming soft drinks at least once a day in the last 30 days (Cook Islands Ministry of Health, 2014). A substantial body of international literature highlighted that inadequate consumption of fruits and vegetable and high consumption of soft drinks are predictors of childhood obesity (Al-Hazza et al., 2012; Perichart-Perera et al., 2010; Cutler et al., 2012; Ambrosini et al., 2013). While there are adolescent-based health surveys conducted in the Cook Islands assessing poor health and dietary behaviours among adolescents, none of them has investigated for associations between adolescent health and health-related KAB. In particular, none of the surveys measures attitudes and knowledge, but commonly focuses on dietary behaviours. Therefore it is unclear whether low fruit and vegetable consumption and high intake of fizzy drinks contribute to the high prevalence rates of overweight/obesity among Cook Islands adolescents. This study aims to fulfil this gap in the literature.

The Cook Islands

The location

The Cook Islands are located in the South Pacific Ocean, northeast of New Zealand, between French Polynesia and American Samoa. There are 15 major islands which spread over 2,200,000 square kilometres of ocean. The Cook Islands are divided into two distinct groups: The Southern Group and The Northern Group. The Southern Group includes Aitutaki, Atiu, Mangaia, Manuae, Mauke, Mitiaro, Rarotonga and Takutea. The Northern group includes Manihiki, Nassau, Palmerston, Pukapuka, Rakahanga, Suwarrow and Tongareva. The Cook Islands main population centres are on the island of Rarotonga where it holds 75% of the total population (Cook Islands Ministry of Health, 2015). This study is conducted and is based on Year 9 students living on the island of Rarotonga.

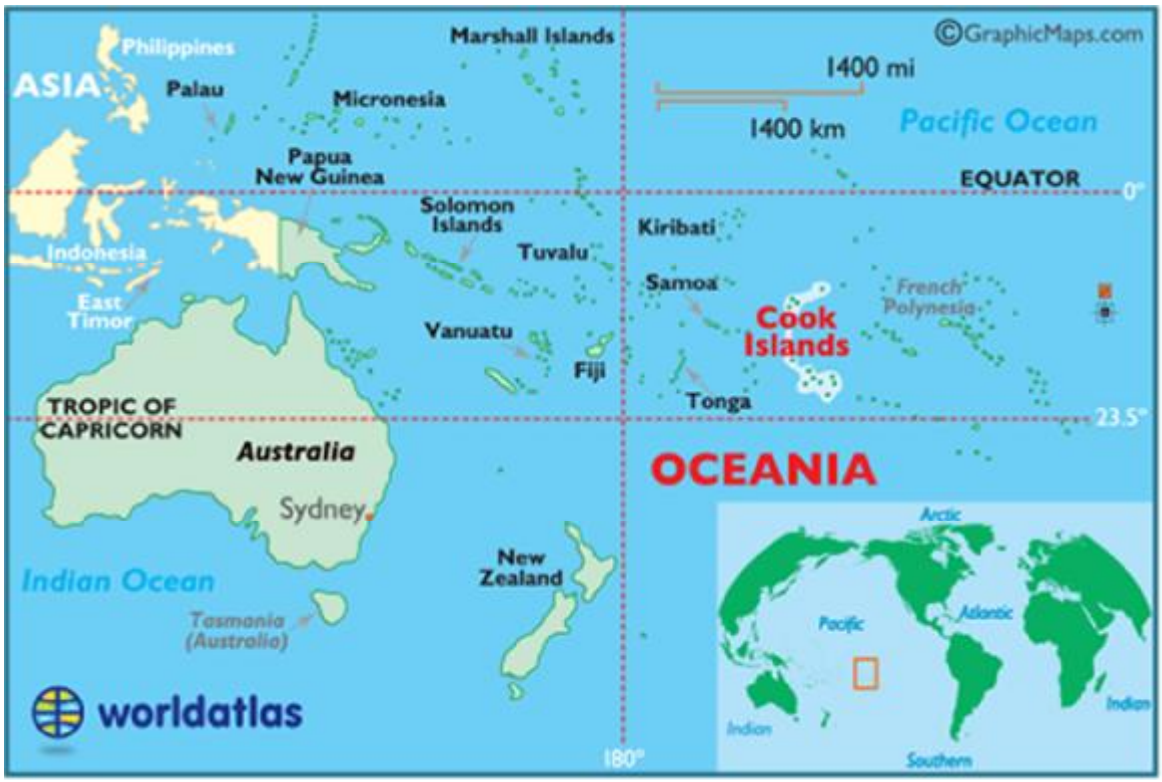


Figure 3: Map showing the location of the Cook Islands in the Pacific region (Worldatlas, 2015)

The Cook Islands have one of the best Millennium Development Goals and Human Development Index (0.83) rating in the Western Pacific Region. The Cook Islands have a reasonable level of maternal health, low infant mortality and high childhood immunisation coverage. However, non-communicable diseases such as cardiovascular, cancer, diabetes, respiratory problems and risk factors such as hypertension and obesity are amongst the leading cause of morbidity and mortality in the Cook Islands. NCDs are responsible for 74% of all deaths (World Health Organization, 2016). Between the period 2009 and 2013, the probability of dying between 15 and 59 years of age is 16% (Iorangi, Tangimetua, & Secretariat of the Pacific Community, 2015), which is slightly higher than the average HIC's premature deaths under 60 years old (13%). This indicates how substantial the NCD epidemic is in the Cook Islands that continues to threaten its development and growth. Although efforts are put in place to help combat NCD, however with a high premature death rate and trends increasing over the years indicates the urgent need for an effective NCD risk reduction strategy in the Cook Islands.

The Cook Islands Population

According to the 2011 Cook Islands Census, the estimated total population is 17,794 (Cook Islands Ministry of Finance and Economic Management, 2012). 84% of this is made up of the resident population. There is a normal distribution of females and males in the Cook Islands. Adolescence (age 10 to 19 years) make up 18% of the total resident population. Approximately 68% of these adolescents are living on the island of Rarotonga. The total 10 to 14 years age group of which the adolescent target group of 12 to 14 years old sat within represents about 35% of the adolescent population in the Cook Islands. This proportion of adolescents are the future adults and parents of the Cook Islands, therefore their health and wellbeing are crucial.

Figure 3 below shows the demographic profile of the Cook Islands population by age group and sex.

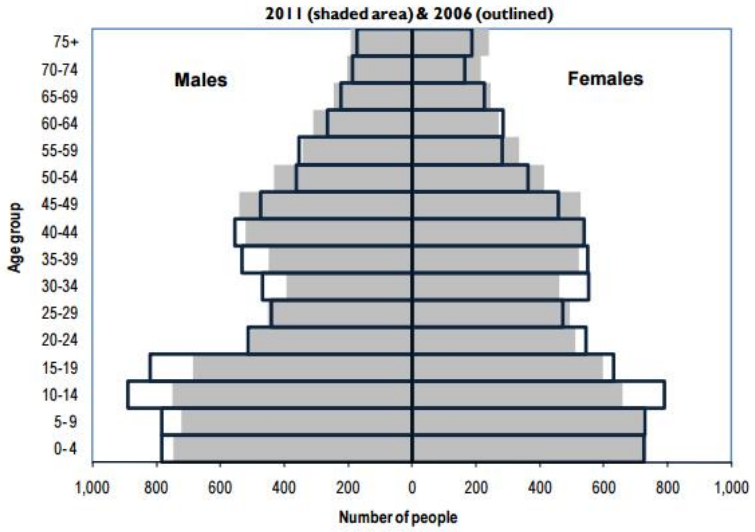


Figure 4: Population pyramid, resident Cook Island population (Cook Islands Ministry of Finance and Economic Management, 2012)

Research aim

This baseline study aims to examine the associations between anthropometric and health-related knowledge, attitudes and behaviours of Year 9 students in Rarotonga prior to participating in PSHLP learning programmes in 2016.

Objectives

To examine within a cohort of Rarotongan Year 9 students:

a) factors contributing to NCD risks
b) health-related knowledge, attitudes and behaviours
c) associations between factors contributing to NCD risks and health-related knowledge, attitudes and behaviours

Thesis structure

This thesis consists of five chapters.

Chapter one: Introduction

The introductory chapter outlines the aims and objectives of this study. It begins with setting the scene on who the researcher is and how the topic was developed. Next, it describes the global epidemic of NCDs along with its risk factors and socioeconomic consequences. It also describes the framework underpinning this study: Developmental Origin of Health and Disease. A demographic of the Cook Islands adolescent population are also provided.

Chapter two: Literature review

Chapter two provides an account of what has been published by organising and synthesising international and national literature. A systematic approach was applied to search for relevant literature. Studies were included in the review if it assessed for associations between anthropometric factors and health-related KAB, among adolescents. The included studies were reviewed for key themes and a description of it is provided in this chapter.

Chapter three: Methodology

Chapter three presents the research method utilized in this study. This section outlines the conceptual framework, and the researcher's positionality used to guide the study design. It also provides an explicit description of the study design undertaken to investigate the overall research aim. A cross-sectional approach was used to examine the associations between adolescent health and health-related KAB.

Chapter four: Results

Chapter four presents the findings yielded from the matched data between anthropometric and health-KAB. This section is presented in four parts: demographic profile, anthropometric profile, health-related KAB profile and associations between health and health-related KAB.

Chapter five: Discussion, recommendations and conclusion

Chapter five discusses key findings from this study in light of international and national literature. Research recommendations on the current paucity of literature are provided. A summary of the strengths and limitations of this study are also described. This chapter concludes the thesis by summarising all the key findings arising from this work.

CHAPTER TWO: LITERATURE REVIEW

Utia mai taku vaka
Toiia mai taku vaka
Utiia mai
Toiia mai
Taku vaka Tupuna
I-e-e-e-ko….ko"
Pull my canoe
Push my canoe
Pull and push
The canoe of my ancestors
It is so……
- Te Vaka Takitumu

Introduction

This chapter examines the existing literature on associations between adolescent health and health-related knowledge, attitudes and behaviours (KAB). A systematic approach was applied to search for relevant literature. The overall themes identified from the review of the included studies are described in this chapter. Followed by a discussion on critical areas found in the review of these themes. This chapter concludes by highlighting key points found in the review.

Aims

This review aims to explore what is known about the influences of health-related KABs on factors contributing to NCD risks among adolescents and to identify any significant gaps in the literature.

Method

The literature review utilized a systematic approach to identify, collate and synthesize evidence on the influences of health-related KABs on adolescent health. A systematic review follows an organized method of locating, assembling, and evaluating a body of literature on a particular topic using a set of specific criteria. Whereas a non-systematic review does not follow a explicit method to identify relevant studies, and possibly uses a set of criteria (Kitchenham, 2004). This systematic review involves three steps: search, assess and integrate.

Search

A search strategy was developed to identify published articles on associations between adolescent health and health-related KAB. This search was carried out in three electronic databases accessed through the University of Auckland: Scopus, PubMed and Google Scholar. Further searches were carried out on the University of Auckland library catalogue to identify journal articles that were not found through electronic search. The reference list of studies included in this review was interrogated for additional articles.

Keywords and phrases were formulated from the study aim. Advanced search techniques were used such as Boolean operators when searching databases by applying AND's and OR's. For example, 'NCD' OR' 'metabolic' AND 'knowledge' AND 'adolescents'. The main words and phrases used in the search query are shown in table 1.

Table 1: Key search words and phrases

	Keywords/phrases	Other keywords/phrases used with similar meanings
1	Non-communicable disease risk factors	Metabolic/anthropometric/obesity/BMI/hypertension/central obesity/cholesterol
2	Knowledge	Awareness
3	Attitude	Self-esteem
4	Behaviour	Practices
5	Pacific	Pasifika/Polynesia/Micronesia/Melanesia
6	Adolescents	Children/young people

Assess

The databases were searched for studies published from January 2000 to July 2017. The inclusion criteria were established to include studies assessing associations on adolescent health and health-related KABs. Studies that did not assess associations were excluded from this review. The detailed exclusion and inclusion criteria guiding the selection of studies for the review are shown in table 2. Figure 5 further demonstrates the process used to select the appropriate and relevant literature on the topic of interest.

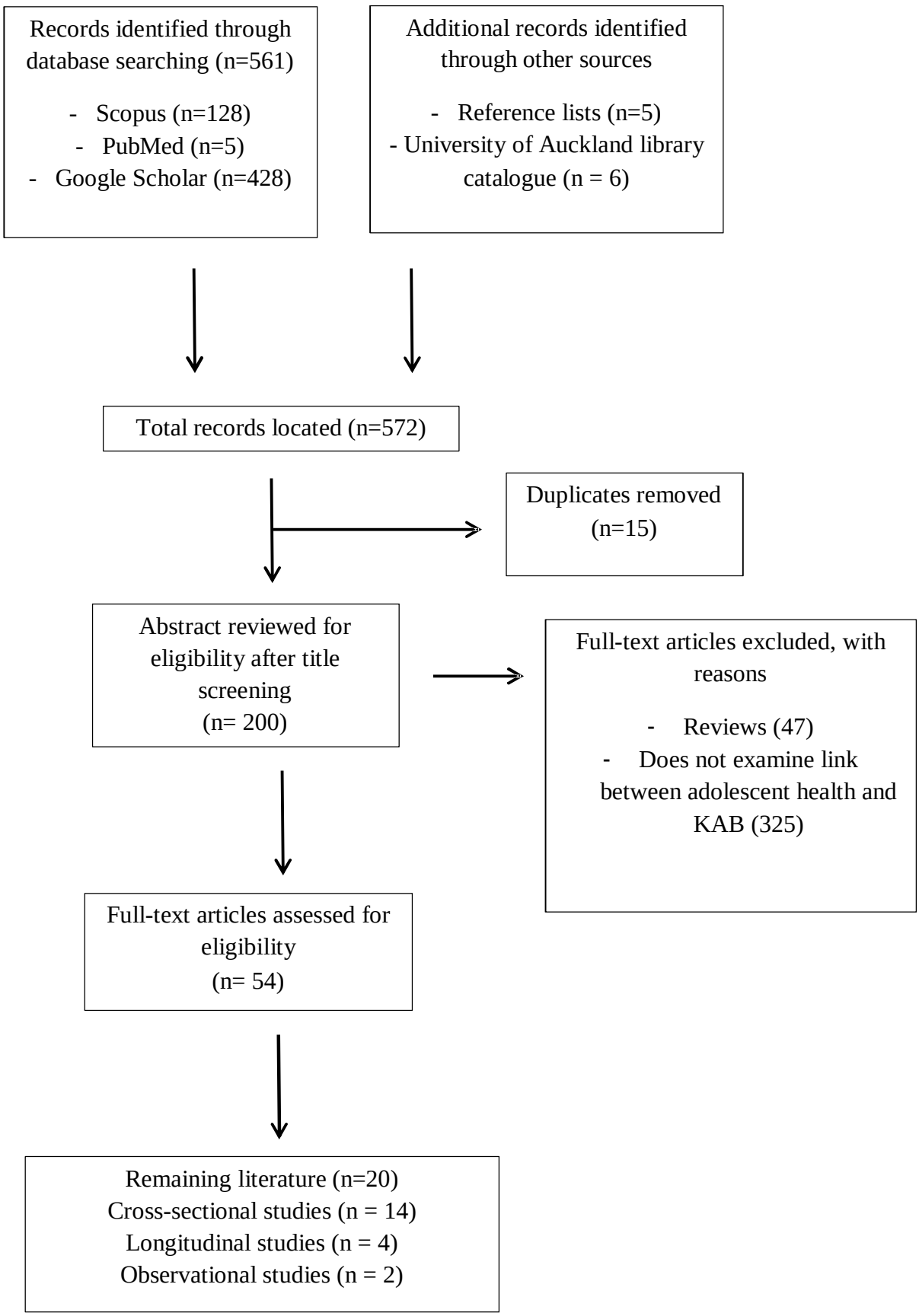
Table 2: Inclusion/exclusion criteria

Inclusion Criteria	Exclusion criteria
Original studies	Systematic reviews, debates or commentaries
Quantitative	Qualitative
Published > 2000	Articles published < 2000
Full texts online	Full texts not easily accessed online
English	Other languages
Subjects 10 to 19 years	Subjects above 19 years of age

Integrate

The final step of the systematic review involves the student researcher synthesising and integrating the findings and combining them into common themes. A theme can be a piece of message that links different set of information together about a particular topic. This was achieved by putting a table together which extracted data based on the following: study characteristics (authors, year, age group, country, study design, statistical method, and sample size), main findings (statistical significance of differences) and limitations. The purpose of tabling the data was to put all the findings together as a whole making it easier for the student researcher to identify common themes and gaps in literature for future research (table 3).

Figure 5: Flowchart for study identification and selection process



Findings

Table 3: Descriptive summary of the included studies

No.	Authors	Year	Age group	Country	Study Design	Statistical methods	Sample size (n)	Main findings	Limitation
1	Milosavljevic et al.	2015	17-19 years	Croatia	Cross-sectional	ANOVA	117	There is an association between BMI (> 25) and low level of knowledge about healthy food choices and awareness of association of certain foods with certain diseases.	Self-reported survey Self-reported BMI
2	Schert-Hellert et al.	2011	12.5 – 17.5 years	Multi-national study (Austria, Belgium, France, Germany, Greece, Hungary, Italy, Spain and Sweden)	Cross-sectional	Wilcoxon signed-rank tests	3,546	There is no association between Nutritional knowledge scores and greater BMI ($p < 0.0001$).	
3	Kostanjevec et al.	2012	11	Slovenia	Observational	ANOVA	630	Children with poorer nutritional knowledge are more likely to eat foods high in fat presenting with health risks such as obesity. There is an association between poor nutritional knowledge and high consumption of pizza ($p < 0.028$) and hamburger ($p < 0.002$) and sugar-sweetened drinks such as carbonated drinks	Self-reported questionnaire

No.	Authors	Year	Age group	Country	Study Design	Statistical methods	Sample size (n)	Main findings	Limitation
								($p > 0.002$).	
4	Wade et al.	2017	10 – 15 years	Belarus	Longitudinal	Multivariate mixed-effects logistic regression	13,557	There is an association between problematic eating attitudes and childhood obesity and hypertension. Positive association found between problematic eating attitudes at age 11.5 years with new-onset obesity ($p < 0.0001$), high systolic blood pressure ($p < 0.02$) and high diastolic blood pressure ($p < 0.06$) at 16 years	Self-reported survey
5	Gordon-Larsen.	2001	11 – 15 years	USA	Cross-sectional	Wilcoxon signed-rank tests	32	No significant differences in self-esteem, eating attitudes and BMI. The mean attitude scores were similar across the obese (8.63) and non-obese (8.84) groups.	Small sample size
6	Ambrosini et al.	2013	14 – 17 years	Australia	Longitudinal	Mixed logistic regression	1,433	There is an association between high intake of sugar-sweetened beverage and obesity and cardiometabolic risks among adolescents. Girls who consumed more than 1.3 servings of sugar-sweetened beverage between 14 and 17 years of age had increases in BMI ($p < 0.001$), overweight ($p < 0.001$), obesity ($p < 0.001$) and cardiometabolic risk ($p < 0.001$). Girls and boys who consumed more 1.3 servings of sugar-sweetened beverage	

No.	Authors	Year	Age group	Country	Study Design	Statistical methods	Sample size (n)	Main findings	Limitation
								showed increases in triglycerides ($p < 0.03$)	
7	Ambrosini et al.	2010	14 years	Australia	Cross-sectional	ANOVA	1,139	There is an association between western diets and clusters of NCD risk factors in girls. Higher western dietary pattern scores were associated with greater odds for the high risk metabolic cluster ($p > 0.02$), total cholesterol ($p > 0.03$), waist circumference ($p > 0.03$) and BMI ($p > 0.02$) in girls, but not for boys.	Self-reported survey
8	Keski-Rahkonen et al.	2003	16 years	Finland	Cross-sectional	Multivariate logistic regression	5,448	Skipping breakfast was associated with obesity in adolescents. Obese students tend to have breakfast once a week ($p < 0.05$).	Self-reported heights and weights
9	Cutler et al.	2012	15-22 years	USA	Observational study	Multivariate logistic regression	2,516	Obesity is associated with low vegetable intake and high sweet, salty snack and starchy food in adolescents. High scores for vegetable pattern were associated with decreased odds of being overweight/obese in older girls ($p < 0.05$). Higher scores for sweet & salty snack food pattern were associated with increased odds of being overweight/obese in older boys ($p < 0.05$). Higher scores in starchy food pattern were significantly associated with	Self-reported heights and weights

No.	Authors	Year	Age group	Country	Study Design	Statistical methods	Sample size (n)	Main findings	Limitation
								higher odds of being overweight/obese in younger boys ($p < 0.05$)	
10	Garcia-Continente et al.	2015	17-18 years	Spain	Cross-sectional	Bivariate and multivariate logistic regression	3,089	Skipping breakfast and unhealthy eating was associated with overweight and obesity in adolescents. Students who are overweight ate breakfast 0 – 1 days per week ($p < 0.001$). Overweight is associated with higher intake of unhealthy food ($p < 0.001$). Obesity is associated with higher intake of unhealthy foods ($p < 0.001$)	Self-reported questionnaire
11	Ludwig et al. (Milosavljevic, Mandic, & Ines, 2015)	2001	11 – 12 years	USA	Cross-sectional	Logistic regression	548	The sugar-sweetened beverage is associated with childhood obesity. Regular consumption (> 3 days per week) of sugar-sweetened beverage is associated with obesity ($p = 0.02$).	Small sample size
12	Hatami et al.	2014	10-18 years	Iran	Cross-sectional	Multivariate binary logistic regression	1,157	High intake of energy-dense food is associated with childhood obesity. Regular consumption of foods that are energy-dense are significantly associated with overweight/obesity ($p < 0.001$)	Self-reported questionnaire (recall bias)
13	McNaughton et al.	2007	12 – 18 years	Australia	Cross-sectional	Linear regression analysis	764	No significant association between dietary patterns and systolic blood pressure, BMI or waist circumference.	
14	Pengpid &	2015	13-16	Multi-	Cross-sectional	Bivariate and	10,424	Carbonated drink are a predictor	Weight and

No.	Authors	Year	Age group	Country	Study Design	Statistical methods	Sample size (n)	Main findings	Limitation
	Peltzer.		years	national study (Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu)		multivariate logistic regression		of overweight in adolescents. Overweight was associated with high intake of carbonated drinks (one or more drinks per day) ($p < 0.01$)	height self-reported Self-reported survey
15	Cartwright et al.	2003	11 – 16 years	UK	Cross-sectional	Multiple linear regression	4,320	Overweight adolescents associated with skipping breakfast. Students who eat breakfast less than 3 days per week are more likely to be overweight ($p < 0.01$)	
16	Mota et al.	2008	13 – 17 years	Portugal	Cross-sectional	Linear logistic regression	886	Breakfast skippers tend to be obese children. Obese children were likely to have breakfast less than 4 days per week compared to overweight children ($p < 0.05$).	Self-reported weight and height Self-reported survey
17	Thompson-McCormick et al.	2010	15 – 19 years	Fiji	Cross-sectional	Multivariate logistic regression	523	Breakfast skippers tend to be overweight and obese adolescents. Overweight and obese participants were significantly more likely to skip breakfast than normal-weight participants ($p < 0.05$).	Self-reported survey
18	Al-Hazza et al.	2012	14-19 years	Saudi Arabia	Cross-sectional	Multinomial logistic regression	2,906	Overweight/obesity and central obesity among adolescents are associated with skipping breakfast, inadequate vegetable intake and high consumption of	Self-reported survey

No.	Authors	Year	Age group	Country	Study Design	Statistical methods	Sample size (n)	Main findings	Limitation
								the sugar-sweetened beverage. Overweight and obese adolescents were significantly associated with consumption of breakfast less than 3 days per week ($p < 0.000$). Overweight and obese adolescents were significantly associated with consumption sugar-sweetened drink between 3 and 4 days per week ($p < 0.015$). Adolescents who are centrally obese were significantly associated with consumption of breakfast less than 3 days per week ($p < 0.000$). Centrally obese adolescents are significantly associated with a lower intake (less than 3 days per week) of vegetables ($p < 0.024$). Centrally obese adolescents are significantly associated with higher intake (3 to 4 days per week) of sugar-sweetened drink ($p < 0.001$).	
19	Laurson et al.	2007	10 years	USA	Longitudinal	Linear regression	268	No significant association between BMI and dietary intake.	Self-reported survey
20	Villers et al.	2016	10-14 years	South Africa	Longitudinal	Paired-sample t-test	500	No significant difference between BMI and nutritional behaviour.	Self-reported questionnaire

Overall, 20 studies were included in the review after the full-text screening of the identified articles through systematic database searching (n = 572), title and abstract screening (n = 200), application of exclusion and inclusion criteria (n = 54) and full-text review (Figure 2) (Al-Hazza, Abadussain, & Musaiger, 2012; Ambrosini et al., 2010; Ambrosini et al., 2013; Cartwright et al., 2003; Cutler, Flood, Hannan, Slavin, & Neumark-Sztainer, 2012; Garcia-Continente, Allue, Gimenez-Perez, Ariza, & Sancheze-Martinez, 2014; Gordon-Larsen, 2001; Hatami et al., 2014; Keski-Rahkonen, Kaprio, Rissanen, Virkkunen, & Rose, 2003; Kostanjevec, Jerman, & Koch, 2013; Laurson, Eisenmann, & Moore, 2007; Ludwig, Peterson, & Gortmaker, 2001; McNaughton, Ball, K., & Crawford, 2008; Milosavljevic et al., 2015; Mota et al., 2008; Pengpid & Peltzer, 2015; Schert-Hellert et al., 2011; Thompson-McCormick, Thomas, Bainivualiku, Khan, & Becker, 2010; Villers et al., 2016; Wade et al., 2017).

A total of 18 studies were conducted in a single setting, and two were multi-national cross-sectional studies. Most of the studies were from high-income countries: USA (4), Australia (3), UK (1), Croatia (1), Slovenia (1), Saudi Arabia (1), Finland (1) Portugal (1) and Spain (1). Four studies were from upper-middle-income countries: Iran (1), South Africa (1), Belarus (1) and Fiji (1). One of the multi-national studies was conducted across high-income European countries; Austria, Belgium, France, Germany, Greece, Hungary, Italy, Spain and Sweden. Meanwhile, the Pacific multi-national study consisted of low- and upper-middle-income countries. The low-middle income countries are Kiribati, Samoa, Solomon and Vanuatu while Samoa and Fiji are ranked as upper-middle income countries.

There were 14 cross-sectional, four longitudinal and two observational study designs that were applied to explore associations between adolescent health and health-related KABs.

All of the studies that assessed KAB were measured through self-reported questionnaires or surveys. A total of 15 studies used staff, nutritionist or evaluator to measure the participants' anthropometric data (Al-Hazza et al., 2012; Ambrosini et al., 2010; Ambrosini et al., 2013; Cartwright et al., 2003; Garcia-Continente et al., 2014; Gordon-Larsen, 2001; Hatami et al., 2014; Kostanjevec et al., 2013; Laurson et al., 2007; Ludwig et al., 2001; McNaughton et al., 2008; Schert-Hellert et al., 2011; Thompson-McCormick et al., 2010; Villers et al., 2016; Wade et al., 2017). However, five other studies indicated that their anthropometric measurements were self-reported (Cutler et al., 2012; Keski-Rahkonen et al., 2003; Milosavljevic et al., 2015; Mota et al., 2008; Pengpid & Peltzer, 2015).

The 20 studies that met the eligibility criteria utilized different statistical methods. A sum of 14 studies used some form of regression analyses (Al-Hazza et al., 2012; Ambrosini et al., 2013; Cartwright et al., 2003; Cutler et al., 2012; Garcia-Continente et al., 2014; Keski-Rahkonen et al., 2003; Laurson et al., 2007; Ludwig et al., 2001; McNaughton et al., 2008; Mota et al., 2008; Pengpid & Peltzer, 2015; Thompson-McCormick et al., 2010; Villers et al., 2016; Wade et al., 2017), three studies used ANOVA (Ambrosini et al., 2010; Kostanjevec et al., 2013; Milosavljevic et al., 2015), two studies used Wilcox signed-rank test (Schert-Hellert et al., 2011; Gordon-Larsen, 2001) and one study used paired-sample t-test (Villers et al., 2016). Based on these statistical methods, the reviewed studies were able to present the associations between adolescent health and KAB. The central themes emerged from the review of the 20 studies are further discussed below.

Anthropometric measures and knowledge

Nutritional knowledge has been found to influence adolescent health. Two studies identified relationships between low level of nutritional-related knowledge and increased likelihood of poor health in childhood and adolescence (Milosavljevic et al., 2015; Kostanjevec et al., 2013). For example, a recent study in Croatia investigated the associations between nutritional knowledge and BMI among 117 children age between 17 to 19 years. Milosavljevic et al. (2015) found that adolescents with BMI greater than 25 had the lowest knowledge about healthy food choices and awareness on associations between health and nutrition. This shows that adolescents with insufficient knowledge about nutrition and diet-disease relationships are more likely to be overweight/obese. The authors suggested that unreliable sources of nutrition-related information may have contributed to the poor nutritional-related knowledge among the study participants, for instance, Media and Internet. This indicates how knowledge can be considered as one of the critical factors influencing food choices and poor health outcomes.

However, one study rejected this association between poor health indicators and low nutritional-related knowledge among adolescents. Schert-Hellert et al. (2011) conducted a European multi-national cross-sectional study among 3,546 children age between 12.5 to 17.5 years. This study found no significant association between low nutritional knowledge test scores and students with higher BMI ($p < 0.0001$). The researchers suggested that inferior nutritional knowledge is not per se associated with the prevalence of overweight or obesity in adolescents. This highlights that there may be other factors besides poor knowledge that accounts for the higher BMI among the overweight and obese respondents. This indicates the importance of investigating other factors that may have contributed to adverse health among adolescents.

Anthropometric measures and attitude

Problematic eating attitudes such as very-low-calorie diets and skipping meals are known to increase the risks of NCD among adolescents. Within this review, one article identified associations between problematic eating attitudes and adverse cardiometabolic consequences including overweight/obesity and high blood pressure among adolescents. Wade et al. (2017) conducted a longitudinal study of 13,557 children aged between 11 to 15 years in Belarus. The study found a positive association between problematic eating attitudes at age 11.5 years

with new-onset of obesity ($p < 0.0001$), high systolic blood pressure ($p < 0.02$) and high diastolic blood pressure ($p < 0.06$) at 16 years. After further controlling for socioeconomic confounders, children who reported problematic attitudes at 11.5 years were twice as likely to develop new-onset of obesity at age 16 years. The authors suggest that problematic eating attitudes in early adolescence are linked to high weight gain, binge eating and later development of obesity in mid-adolescence. This shows how problematic eating attitudes can be a contributing factor for poor health among adolescents.

On the other hand, one study refutes against associations found between anthropometric measures and nutritional-related attitudes. Gordon-Larson (2001) conducted a cross-sectional study of 32 children aged between 11 to 15 years in the USA. This study found no significant obese-non-obese intergroup differences in eating attitudes with a mean value of 8.63 for obese groups, and 8.84 for non-obese groups. This shows that neither positive nor negative attitudes towards nutrition affect the likelihood of poor health outcomes among adolescents. The authors suggested that the context the individual lives in might have contributed to the participant's adverse health outcomes, for example, poor socioeconomic conditions. Thus, this indicates the importance of investigating the influences of environmental factors on adolescent health.

Anthropometric measures and behaviour

Nutritional-related behaviours are one of the main factors recognized in the literature contributing to poor health among adolescents. A total of 12 articles acknowledge that poor nutritional-related behaviours such as high-fat foods, inadequate fruit and vegetable intake, sugar-sweetened beverage, skipping breakfast and high-fat takeaway foods could negatively influenced the health of adolescents (Al-Hazza et al., 2012; Ambrosini et al., 2013; Ambrosini et al., 2010; Cartwright et al., 2003; Cutler et al., 2012; Garcia-Continente et al., 2014; Hatami et al., 2014; Keski-Rahkonen et al., 2003; Ludwig et al., 2001; Mota et al., 2008; Pengpid & Peltzer, 2015; Thompson-McCormic et al., 2010). For instance, a cross-sectional study in Spain found associations between breakfast skipping ($p < 0.001$) and higher intake of unhealthy food ($p < 0.001$) among overweight students (Garcia-Continente et al., 2015). Garcia-Continente and colleagues also found that higher intake of unhealthy food was associated with obesity ($p < 0.001$). They suggested that regularly skipping breakfast and eating unhealthy food promotes childhood obesity. Another study identified in this review reported similar findings. Hamai et al. (2014) found in a sample of 1,157 children aged

between 10 to 18 years old in Iran, overweight, and obesity among children was significantly associated with higher intake of energy-dense foods ($p < 0.001$). Therefore, these studies indicate that poor nutritional-related behaviour is linked to increased likelihood of adverse health outcomes in adolescents. It is clear that these associations with food behaviours and health outcomes suggest that early prevention of NCDs urgently needed.

Nonetheless, three studies reject the associations identified between nutritional-related behaviour and poor health among adolescents (Laurson et al., 2007; McNaughton et al., 2008; Villers et al., 2016). For example, a cross-sectional study in Australia did not find an association between dietary patterns, BMI or waist circumference (McNaughton et al., 2008). Another study reported similar findings. Villers et al. (2006) conducted a longitudinal study of 500 children aged between 10 to 14 years in South Africa to investigate the relationship between dietary patterns and BMI. The study did not find any significant difference between nutritional behaviour and BMI. These studies recognised the potential role of prenatal/maternal aspects, genetics and several environmental features as factors contributing to NCD risks among adolescents. This indicates the importance of having health-promoting environments and addressing early-life factors in supporting NCD risk reduction strategies among adolescents.

Discussion

Principal findings

The evidence from the cross-sectional, longitudinal and observational studies carried out have consistently shown that adolescents who have poor KABs have an increased risk of adverse health statuses. However, the majority of these studies were mainly focused on nutritional-related behaviours. Very few of the literature found associations between knowledge, attitudes and factors contributing to NCD risks. Moreover, none of the included studies assessed the influences of all three KABs together on adolescent health. The observed health outcomes among the adolescents could have been due to the interactions that occurred between the three dimensions (KAB) rather than behaviour on its own. For instance, what a person knows and feels may influence a person's behaviour. Measuring all three KAB together can demonstrate the capabilities used to support evidence-based decision makings (Huque et al., 2015), and this is important in reducing the risks for NCD in adolescents.

One of the key findings highlighted in the literature was that there is much focus on measuring childhood obesity. Only two out of the 20 studies included a collective of health indicators such as BMI, waist-to-height-ratio, total cholesterol, low-density-lipoprotein and blood pressure. Although BMI is useful in identifying weight statuses that leads to potential health problems among adolescents, however, it is not the only factor contributing to the development of NCD risks. NCD is a complex issue and caused by multiple factors, focussing on measuring childhood obesity alone is only part of the determinants that affect NCD. Therefore measuring, a range of health indicators such as those aforementioned can give a comprehensive picture of the epidemiological distribution of risk factors for NCDs among adolescents.

While this review found associations, however, the majority of these studies were mainly from developed and high-income countries. Factoring that there were a particular search strategy and terms used, it generated very few studies from middle-and-low income countries. There was no study conducted in a single low-income setting. However, there was one Pacific multi-national study that included a mix of low- and middle-income countries and one conducted in a single setting (Fiji). This highlights the limitation of generalising findings from this review to the Pacific, including the Cook Islands. Despite this, these evidence help create awareness that the low level of KAB is associated with adverse health outcomes among adolescents. This evidence is useful in settings where there is lack of studies on KAB and NCD risks among adolescents such as the Pacific. At the same time, it also highlights the importance of conducting studies looking at the association between adolescent health and health-related KABs to support the ongoing NCD prevention strategies and programs in low-income and developing countries.

Common methods

As aforementioned, majority of the studies reviewed were cross-sectional, only four studies utilized longitudinal study designs. Although it was used, it was an unconventional method adopted compared to other study designs in the literature review. While cross-sectional studies are appraised for its cost-effectiveness and timely nature, however, it has been critiqued as it does not determine whether one factor causes another. As a result, based on this method, it is unclear whether poor health statuses among adolescents are caused by KAB. Nevertheless, the four longitudinal studies identified in this review found associations, which supports and confirms the associations highlighted in the cross-sectional studies that

inadequate levels of KAB are not only associated, but also do cause adverse health outcome among adolescents.

Common limitations

One of the typical limitations identified in the literature review is regarding the health data collection. A total of five studies indicated that their anthropometric measurements were self-reported, in particular around weight and height. Although these studies indicated that the reason why they chose this method was due to large sample size, they still noted it as a limitation. For this reason, self-reported measures have the potential to either underestimate or overestimate BMI. (Shields, Corber, & Mark, 2009). In turn, it can affect the reliability and validity of the measured outcomes (Connor-Gorber, Tremblay, Moher, & Gorber, 2007) and therefore there are limitations in the findings of these studies.

Self-reported questionnaires were highlighted by studies within this review as a limitation. Reasons reported by these studies were due to recall biases and underreporting. This may be true in cases where the questionnaire asks sensitive questions and recall memories of more than a week. However, self-reported questionnaires are useful for places with limited resources such as the Pacific.

Another limitation is the sample size. Only one study reported having a small sample size that consisted of 32 participants (Gordon-Larsen., 2001). Although this study identified this was due to the availability of participants and poor recruitment, they recognised it as a limitation. For this reason, Gordeon-Larsen (2001) acknowledge that it is not a representative sample of adolescents in the study context it researched. As a result, smaller sample sizes can reduce the power of the study and increase the margin of error thereby affecting the validity of the study results (Faber & Fonseca, 2014). Moreover, it could affect the generalisation of the study to other settings with larger populations (Button et al., 2013).

Conclusion

This review found there are associations between poor KABs and adverse health outcomes among adolescents. It also found relationships showing no associations and that there are other contributing factors affecting poor health status among adolescents. Most of the studies supporting the associations found between poor KAB and adolescent health were done using cross-sectional approaches and from high-income and developed countries. There were no studies conducted within low-income countries. There was one multi-national Pacific study

and one conducted in a singular Pacific setting (Fiji), however, there was none found in the Cook Islands. Moreover, most of the reviewed articles mainly assessed KAB individually and childhood obesity. There were only two studies that assessed a wide range of health indicators and no studies assessed the influences of KAB on adolescent health. Therefore this thesis attempts to fill this research gap, by exploring the influences of KAB on a range of health indicators among adolescents in the context of Rarotonga, Cook Islands.

CHAPTER THREE: METHODOLOGY

"Titiro kite Paia e…..
E karo kite tira…..
E tini
E tini
E rau makokore te taura
Naai rai I karangai e
Taparai te enua ngaru
I te enua Atua I runga I te rangi"
Look out to the ship
Look out to its sail
Ship with many ropes and ties
Whom you said that my island belongs to the God of the heavens

- **Ngaka'ara Ariki (Rongomatane Ariki)**

Introduction

This chapter outlines the research methods used in this study. It begins by describing the conceptual frameworks and the researcher's positionality. Followed by a description of the study design used to carry out this research. This study employed a cross-sectional approach to examine the baseline evidence from a multi-cohort longitudinal study in the Cook Islands.

Research aim

This baseline study aims to examine associations between anthropometric and health-related knowledge, attitudes and behaviours of Rarotongan Year 9 students prior to participating in the Pacific Science for Health Literacy Project (PSHLP) learning programmes in 2016.

Objectives

To examine within a cohort of Rarotongan Year 9 students:

d) factors contributing to NCD risks
e) health-related knowledge, attitudes and behaviours (KAB)
f) associations between factors contributing to NCD risks and health-related knowledge, attitudes and behaviours

Theoretical framework- Critical Realism in Cook Island research

Critical Realism Theory (CRT) was coined by Bhaska in 1997. CRT is a philosophical approach that merges science with social science to highlight the intersection between the natural and social worlds. In other words, identifying differences between the assumptions we form and reality (Danemark, Ekstrom, Jakobsen, & Karlson, 2002).

Bhaska explains our understanding of the world are influenced by experiences of events and the mental processes that occur thereafter. For example, an umpire saw the netball player dropping the ball and calls it a foul. The umpire makes the call according to what he or she observes at that point in time. A critical realist would argue what the umpire saw was only a small part of what actually took place. Another netball player may have obscured the umpire's view of the actual event. What the umpire did not see are the underlying causes (real). The umpire used his or her sensory data as empirical reasoning to determine the call (Naeeni et al., 2014) (Figure 2).

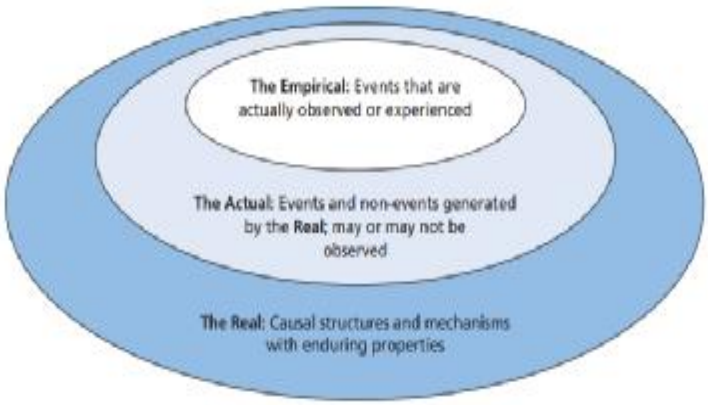


Figure 6: Application of critical realist stratified ontology (Saunders, 2009)

CRT advocates to reduce potential unconscious biases and ensure objectivity in researcher's, it is essential to consider the socio-cultural context and related experiences that may influence the study. This study is conducted within the setting of Rarotonga. It is imperative to be aware that the term Cook Islands includes people from Rarotonga, Atiu, Mangaia, Mitiaro, Mauke, Manuae, Takutea, Aitutaki, Pukapuka, Manihiki, Nassau, Palmerston, Penrhyn and Suwarrow. This term is not homogenous but represents a diverse and distinct range of cultures and traditional practices. Although there are similarities, there are also subtle differences. For example, while the people from each of these islands speak Cook Islands

Māori, variants of this language are found on each island. There are six dialects of Cook Islands Māori spoken within the Cook Islands, including Rarotongan. As a critical realist researcher, it is imperitive to integrate the worldviews of the Rarotongan culture, values and beliefs as the basis for informing the study design, and the interpretation of the evidence collected in this research. However, this study also acknowledges some of the study participants are also descendants of the Outer Islands in the Cook Islands. Their worldviews are also considered in interpreting the data within this study.

Pacific cultural framework – Cook Islands Pe'e or Chants

This thesis integrated Cook Islands traditional chants or Pe'e throughout each chapter. The selection of the chants, or Pe'e, illustrates how the research considered the context of Rarotonga but acknowledge that there are participants whose family origins sat within other islands of the Cook Islands group.

Chapter One - Introduction

The introduction of this thesis was embedded with a *'Urau'* or welcoming chants. *Urau* is a mutual terminology used by Atiuan people when welcoming a person of high calibre (e.g. the prime minister or high chief). This urau is usually conducted by the paramount chief mouth speaker or someone of chiefly line from the sacred land.

This research is culturally regarded as a figurative sacred land that requires a 'Urau' from the people of the land. The people of the land are the multi-sectoral partners involved in this research - the participating members from the Cook Islands Ministry of Health (CIMOH), the Cook Islands Ministry of Education (CIMOE) and participating schools, the Liggins Insitute and the student-researcher. In a reflection of the Cook Islands cultural tradition of implementing the Urau, the student researcher begins this thesis by calling a traditional urau.

Chapter Two – Literature review

The traditional chant used at the beginning of this chapter is about a canoe being prepared for a voyage. There are two groups of men identified in the chant. One group behind the canoe is pushing it forward while the other group is in the front, pulling the ropes attached to the canoe. At this point, the men are toiling with obstacles in nature as they push the canoe into the sea. For this reason, a guider is needed, who is responsible for directing the canoe towards the sea.

The canoe is a figurative representation of the study aim and objectives. The guider can be viewed as the literature review conducted to direct where the research findings fit into the existing body of knowledge and how it has been studied and interpreted by previous researchers.

Chapter Three - Methodology

The traditional chant introducing chapter three revolves around the canoe in search of land. A range of factors for travel across the ocean is considered crucial in successfully finding land. This includes the design of the canoe, the cooperation among the sailors, and how they navigate the canoe across the ocean.

Finding the land can be viewed as the primary research question being answered. The methods employed by the men to successfully build and navigate the canoe represents the steps implemented to address the research question. The joint cooperation among the sailors can be regarded as the relationship between the student-researcher and the Cook Islands community who are all participators in this research.

In this study, the: participating school communities including students and their families, teachers, school leaders and school support staff, the participating ministry of education leaders and academic staff, participating ministry of health leadership and health teams were all highly valued and well respected. The collaborating partners co-constructed the overall research programme including this present study. They were consulted throughout the process to ensure that data analysis and reporting were aligned to their local vision. The CIMOH vision is: "*all people living in the Cook Islands living healthier lives and achieving their aspirations*". The CIMOE vision is as follows, to: "*build the skills, knowledge, attitudes and values of Cook Islanders to put their capabilities to best use in all areas of their lives*". Similarly, parallel to the chant, together with the Liggins Institute and the student-researcher, when all parties work collectively and cooperatively together, they will increase the chance of discovering land.

Chapter Four – Research findings

The traditional chant introducing chapter four is about the canoe landing ashore. Before landing, there were massive rains and mighty winds making their arrival difficult. The people on the canoe called upon the God of the Sea to calm the storm down, so they can safely land.

The land is seen as the result section of this research. The God of the Sea can be viewed as the student-researcher who must carry out rain and wind-like factors such as; data analysis, data cleaning and statistical tests to obtain the key findings (result) outlined in this research.

Chapter Five – Discussion, Recommendation and conclusion

The traditional chant introducing chapter five is about dedicating the land. The traditional leader or healer blesses the land and dwellers to be fruitful. The chant ends with a prophesy stating that the land will not be destroyed and will flourish forever.

The land can be perceived as the key findings of this research. The fruitfulness of the land signifies the benefit of this study, which will contribute to knowledge about adolescent health in Rarotonga that can be applied to support ongoing NCD risk reduction strategies. The prosperity of the dwellers means this research will be reported back to the CIMOH, CIMOE, study participants and the overall Cook Islands community. This research will also be presented at the 2018 Cook Islands Annual Health Conference, deposited as a publically available thesis in the University of Auckland library, and in part will be submitted for potential publication to an academic journal.

Researcher as an 'Insider'

Being an 'insider' research is important in this study because of the direct involvement or connection of the student-researcher with the research setting (Dwyer & Buckle, 2009). In particular, insider researchers hold in-depth special knowledge about the community and its people and can culturally relate to the participants than someone who is not (Mercer, 2007). In turn, they are better able to obtain a richer set of data. Even though outsider researchers are valued for their objectivity and emotional detachment from the situation, but may have difficulties gaining access to research participants and understanding the study context (Unluer, 2012). This highlights the importance of employing an 'insider' researcher in this study.

As a Cook Islander, I was invited to join the PHSLP large interdisciplinary study team as a student-researcher to undertake an analysis of baseline data with the third cohort of year 9 students in the Cook Islands arm of the PSHLP pilot project. Participating researchers from the partaking government ministries, the partner schools and myself are all 'insiders' within this research project.

Study Design

This study employed a cross-sectional protocol. The evidence generated from this thesis will contribute to understanding how health-related KAB in adolescents may influence future health outcomes. The findings will also be compared to future data collected from the same group of students to assess the impact of participation in the Project on health outcomes in the longer-term (i.e. more than 12-months) (i.e. body mass index and blood pressure).

Data collection

This study was approved by the Cook Islands Research Committee (Ref. 05/14 and 05/14a) and the University of Auckland Human Participants Ethics Committee (Ref. 011207).

Adolescent health checks

The collection of anthropometric and metabolic health indicators was embedded within a regular CIMOH procedure of biannual data checks for all school-age children and adolescents. This process collected the measurements of height, waist circumference, blood pressure, total cholesterol and low-density-lipoprotein and are described below. The school students were invited to take part in this health check, and informed consent forms were obtained from students and parents of students below the age of 16 years. The health check was carried out at school within a class period approximately 50 minutes. Five stations were set up in the classroom where the students are given the opportunity to rotate around each area. Due to the limited time given to conduct the health check, all of the participants' anthropometric measures were only taken once.

- The height was measured while the participants were in the standing position with shoes and socks removed to the nearest 0.1 centimetres by a portable wall-mounted stadiometer with a movable headboard.
- The weight was measured in light clothing with shoes removed to the nearest 0.1 kilograms by a Seca 813 Digital scale.
- Waist circumference was measured by horizontally positioning a Myo tape measure across the belly button.
- Blood pressure was taken after one minute resting while in a sitting position on the right arm. An Omron HEM-7203 automatic blood pressure monitor was used to measure both the systolic and diastolic readings of the participants.

- The participants' total cholesterol was measured by taking a small blood sample from a finger prick, placed on a cholesterol test strip and inserted into the Cardiocheck PA Analyser.
- The same process was applied for measuring low-density-lipoprotein (LDL). However, a finger prick of a small blood sample was placed on an LDL test strip and inserted into the Cardiocheck PA Analyser.

PHSLP survey data

The Rarotonga Year 9's KAB data was collected by the PSHLP project team at pre-intervention (T0) in 2016. This cohort of students was invited to participate, and informed consent was obtained from students and parents of students under 16 years of age. A self-administered paper-based questionnaire was used to collect information on KAB, and this was done at school within one class period (approximately 50 minutes). This was administered by the participating PSHLP project team members who went through the questionnaires with the student to ensure that they understand it. Examples were used to elaborate on some key areas such as servings sizes. A participating teacher from the CIMOE team was present to supervise the students while they carry out the survey. The survey was held with permission from the schools at an appointed time to ensure that there is no disturbance to their ongoing schedules.

Data analysis

The following three subsections outline the main analysis procedures utilised in this study: data cleaning, data coding and statistical analysis. These procedures present how the data was processed and arranged to examine the association between anthropometric and KAB.

Data cleaning

The anthropometric data were provided in the categorised form. The KAB data was only provided in a raw form which necessitated a cleaning process. This involves interrogating the raw data sheets for entry errors, duplications and missing data.

Data coding

The data coding process involves categorising the raw data for analysis. The following sections outline and define the KAB and health variables.

Knowledge

The PSHLP survey collects seven questions relating to knowledge about associations between early-life environmental exposures and later-life health and well-being. All of the knowledge questions were utilized in this study to measure the students' level of awareness on the Developmental Origins of Health and Disease (DOHaD) framework. The knowledge questions offered the respondents' five options within a Likert scale being: strongly agree, agree, I don't know, disagree and strongly disagree. In SPSS, these five responses were numbered from one to five starting from strongly agree and ending with strongly disagree accordingly.

Attitude

The PSHLP survey collects three questions regarding students' attitudes toward nutrition and physical activity. In a reflection of the research aim of this study, physical activity was excluded from this analysis. The attitude questions offered the respondents four options within a Likert scale being: a lot, some, not very much and not at all. Similarly, when this data was processed, these four responses were represented by numbers from one to four starting from a lot and ending with not at all in SPSS.

Behaviour

The PSHLP survey asked 46 food consumption and five meal pattern questions. The meal patterns were measured in days per week. The food consumption patterns were measured at two levels: days per week and servings per day. The student-researcher analysed the food consumption patterns in both levels and the results yielded were similar. Therefore days per week were chosen to analyse food consumption patterns among the study participants. The categorisation for the food consumption and meal patterns are explained in more detail below.

1) Protective food items

Eleven questions were asked regarding protective foods, this study selected three items: fresh fruit, raw or salad vegetables and cooked green vegetables. Cooked starchy vegetable (e.g. taro, kumara and maniota) was excluded from this analysis as this study is interested in examining whether participating adolescents were fulfilling the World Health Organization (WHO) fruit and vegetable recommendations of two servings of fruit and three servings of vegetables daily, across the week. The survey responses were grouped into two groups: 'at

risk' and 'no risk' as shown below. These are categorised according to the WHO recommendation for fruit and vegetable intake per week (Agudo, 2005).

At risk group	No risk group
Never	4 – 5 days per week
One day per week	More than 5 days per week
2 – 3 days per week	

2) High-fat foods

The PSHLP survey asked six questions regarding foods high in fat. This study selected three high-fat food items: doughnuts, hot chips and meat pies or sausage rolls. These three high-fat foods were chosen based on results from past cohorts within the overall PSHLP study where it was identified as the most commonly consumed energy-dense foods by adolescents in Rarotonga. The WHO's recommended intake of high-fat foods is less than one day per week (World Health Organization, 2008). The survey responses were grouped into two groups: 'at risk' and 'no risk' as shown below.

At risk group	No risk group
2 – 3 days per week	Never
4 – 5 days per week	One day per week
More than 5 days per week	

3) Sugar-sweetened beverages

The PSHLP survey asked five questions regarding sugar-sweetened beverages (SSB), and this study chose to analyse one SSB: regular fizzy or soft drinks. Both terms were used in the survey as it was identified that these were the usual phrases used in the community to describe sugar-sweetened carbonated beverages. Examples were given in the survey based on locally available brands. Teachers and researchers conducting the survey went through each food type with the class to ensure the students realised this was about sugar-sweetened and not diet or artificially sweetened carbonated drinks. This study chose to analyse regular fizzy or soft drinks given that it was the most identified SBB drink consumed at least once a day by Cook Island adolescents age between 13 – 15 years (60.2%) in the Cook Islands Global School Health Survey (Cook Islands Ministry of Health, 2016). The WHO's recommended

intake of sugar-sweetened beverage is less than one day per week (World Health Organization, 2015b). The survey responses for SSB were grouped into two categories: 'at risk' and 'no risk' as shown below.

At risk group	No risk group
2 – 3 days per week	Never
4 -5 days per week	One day per week
More than 5 days per week	

4) Meal Patterns

There were five meal patterns asked in the PSHLP survey and this study chose two: high-fat takeaway foods and breakfast meal patterns. Breakfast and high-fat meal patterns were chosen because current literature highlighted as one of the leading risk-factors for obesity among adolescents (Franks et al., 2010). The WHO's recommendation for breakfast is more than five days per week and for high-fat takeaway foods is less than one day per week (Michaelsen, Weaver, Branca, & Robertson, 2000). The survey responses were put into two groups: 'at risk' and 'no risk' as shown below.

Breakfast		High-fat takeaway food	
At risk group	**No risk group**	**A risk group**	**No risk group**
Never	4 – 5days per week	**2 – 3 days per week**	Never
One day per week	More than 5 days per week	**4 – 5 days per week**	One day per week
2 – 3 days per week		**More than 5 days per week**	

Adolescent Health Data

The CIMOH health data were defined and categorised based on the following descriptions below.

1) Body Mass Index

Body mass index (BMI) is a commonly used screening tool to indicate whether a person is a healthy weight or not (Engeland, Bjorge, Sogaard, & Tverdal, 2003). For children, BMI varies with age and sex, not only weight and so they are age and sex-specific. The BMI for children is calculated by dividing a child's weight in kilograms by the square of height in meters (BMI = Weight/Height^2). Take the BMI values and obtain the age and sex of the child

and plot it on the World Health Organization's BMI-for-age Z-score chart for children aged 5 – 19 years to identify their Z-score which is measured in standard deviation (SD) (Kjollesdal et al., 2016). Each student was assigned SD with median BMI based on their age and sex as shown below. Although BMI has been criticised for not measuring body fat directly but is useful in screening for weight categories that may lead to health problems.

Classification	BMI standard deviation
Severely Underweight	< -3 SD
Underweight	< -2 SD
Healthy	Median Range/SD 0
Overweight	> +1 SD
Obese	> +2 SD
Severely obese	> +3

2) ***Waist-To-Height-Ratio***

Waist-to-height-ratio (WHtR) is used to find out if an individual is carrying extra fat around the middle area (Colin-Ramirez et al., 2009). It is calculated by taking the waist measurement and dividing it by height. The table below shows the classification of central adolescent obesity, and this was used in this study. Adolescents with a WHtR ratio greater than 0.5 means they have too much belly-fat (around the middle). There is a consensus in the literature on whether WHtR should be used alongside BMI or on its own. In this study, WHtR was used on its own.

Classification	Waist-to-Height-Ratio
Low risk	0.5 or less
Increased risk/Central obesity	Greater than 0.5

3) ***Blood pressure***

Blood pressure (BP) measures the strength required to move blood forward and against the side of the blood vessels (McCarron, Smith, Okasha, & McEwen, 2000). The measurements taken can determine whether an individual is at risk of hypertension, which is a risk factor for NCD such as cardiovascular diseases. In this research, the participants were classified using the 'Age-Based Paediatric Blood Pressure Reference Charts' calculator. The table below indicates the levels of percentiles. However, the prehypertension and hypertension categories were combined and re-coded as 'raised' in this study. This indicates the participants

estimated risks of getting prehypertension and hypertension. For this reason, the participants BP were measured only one time, and it has been suggested to improve accuracy must take two or three repeated readings.

Classification	Blood pressure
Normal	50th - 90th Percentile
Prehypertension	90th - 95th Percentile
Hypertension	95th - 99th Percentile

4) Blood cholesterol

Total cholesterol can estimate a person's risk of getting heart disease and stroke (Voight et al., 2012). For this study, the American Academy of Paediatrics cut-offs were used for children or adolescent. The table below shows the classification used in this study.

Low-density-lipoprotein is considered as 'bad cholesterol' (Voight et al., 2012). A build-up in the artery wall can make it hard for the blood to flow efficiently increasing the risk of causing blood clots. In turn, this can cause the development of circulatory diseases. The table below shows the acceptable level for LDL.

Classification	Total cholesterol	LDL
Acceptable	< 4.4mmol/L	< 2.8mmol/L
Borderline	4.4 – 5mmol/L	2.8 – 3.3mmol/L
High	> 5mmol/L	> 3.3mmol/L

Ordinal logistic regression test

An ordinal logistic regression test was performed to assess associations between factors contributing to NCD risks and KAB. The test is used to predict an ordinal dependent variable given for one or more independent variables (Laerd Statistics, 2017). Before performing this test, it must go through a checklist to see if this is the right statistical method for this study.

The ordinal logistic regression test has four assumptions. The first two assumptions relate to the choice of study design, while the other two assumptions relate to whether the model fits the study design.

The first assumption indicates that the independent variable must be measured at ordinal level. An example of ordinal variables includes Likert Items (e.g. 7 point scale from "strongly

agree" through to "strongly disagree"). The second assumption indicates that there must be one or more independent variables that are continuous, ordinal or categorical. An example of the continuous variables includes; age, revision time and income and examples of categorical variables include; gender, ethnicity and profession. The third assumption indicates there must be no multicollinearity (Laerd Statistics, 2017). Multicollinearity occurs when two or more independent variables are highly correlated with each other. The fourth assumption conveys that it must have proportional odds. Assumption three and four can be checked utilising SPSS statistics.

The dependent variables in this study are ordered, and independent variables are continuous or categorical, therefore this passes the first two assumptions. For example, the knowledge questionnaire is measured using the Likert Scale, and health data are categorical. The ordinal logistic regression test was used to assess associations between knowledge, attitudes and WHtR, LDL, TC, BP and BMI. This test was also used to assess associations between BMI and behaviour to determine odds between overweight vs healthy and obese/severely obese vs healthy. An attempt was made using binomial logistic regression to assess the association between BMI and behaviour, but it only yielded one proportional odds for obese/severely obese vs healthy. However, for associations between WHtR, LDL, TC and BP and behaviour, this was assessed using binomial logistic regression test as it did not pass the first two assumptions of for the ordinal logistic regression test.

Binomial logistic regression test

A binomial logistic regression predicts that the probability that an observation falls into one of two categories of dichotomous dependent variables based on one or more independent variables, that can be either continuous or categorical (Laerd Statistics, 2017). Similarly, like the ordinal logistic regression test, it must go through a checklist process to ensure this is the correct method.

The first assumption states that the independent variable must be measured on a dichotomous scale. The behaviour data has been categorised into dichotomous variables, for example, 'at risk' and 'no risk'. The second assumption highlights that one or more independent variables are either continuous or categorical. The health data in this study are categorical. The third assumption states that the data must have the independence of observations and that the dependent variable should have mutually exclusive and exhaustive categories. The fourth assumption states there needs to be a linear relationship between any continuous independent

variables and the logit transformation of the dependent variable (Laerd Statistics, 2017). Assumptions four and three can be checked using SPSS.

According to the binomial logistic regression test as along it meets the first two assumptions, then this is the correct test. The data for this study does meet the first two assumptions of the binomial logistic regression test.

Conclusion

This chapter provided a brief description of the overall conceptual framework and its relation to the Pacific Framework and insider researcher. These three frameworks were utilized to guide the analysis of the research. The research design employed a cross-sectional approach to investigate the relationship between adolescent health and health-related KAB. This method enabled the researcher to link two sets of data via CIMOH and PSHLP. An ordinal and binomial logistics regression test was used to assess for associations between adolescent health and KAB data. There are different reasons to apply each specific method in this study, and this was justified in this chapter. At the same time, all applied methods have their strengths and limitations which are further discussed in details in the discussion chapter.

In the next chapter, the results generated by applying the methods above are described. Different tables are used to visualise the results

CHAPTER FOUR: RESULTS

"Tangaroa I te titi
Tangaroa I te tata
Eu eu ake ana rai I te rangi
Kia tae atu te vaka o Ru ki uta
Te ua e te matangi
Akarongo marino…..marino"
God of the sea
Open up the windows of heaven
So that Ru's canoe can calmly sail to shore
The wind and the rain
Listen and be calm…..calm……

- **Te Vaka O Ru Ararau Enua ki te Moana**

This chapter presents five key sections arising from examination of the anthropometric and health-related knowledge, attitudes and behaviours (KAB) data. Section one describes the demographic characteristics of the study participants. Section two and three present the matched sample(s) (a) anthropometric and (b) health-related KAB profiles. The fourth section describes the five associations between the anthropometric and KAB data. The final section concludes this chapter by providing a summary of the key findings.

The demographic profile of the Year 9 population 2016

Table 4: Demographic profile of the 2016 Year 9 population

	The 2016 Year 9 cohorts		KAB survey participants		Health measurement participants		Matched sample	
		Students	*n*	*%*	*n*	*%*	*n*	*%*
	All	173	156	90.2	144	83.2	133	76.9
School A	Year 9	32	27	17.3	26	18.1	21	15.8
School B		114	108	69.2	104	72.2	100	75.2
School C		27	21	13.5	14	9.7	12	9.0
Sex	Male	88	76	48.7	74	51.4	64	48.1
	Female	85	80	51.3	70	48.6	69	51.9
Median age (interquartile ranges)	Year 9	13y7m (12y3m to 14y9m)	13y6m(12y4m to 14y8m)		13ym6 (12y4m to 14yr8m)		13y5m(12y10m to 14y9m)	
Ethnicity	Cook Islands Maori		146	84.4			125	72.3
	New Zealand		48	27.7			39	22.5
	Other Pacific		22	12.7			17	9.8
	Other		15	8.7			12	6.9

Missing ethnic data for total year 9 cohorts and Health measurements except for KAB survey and the matched sample in this study. Ethnic data based on multiple answers. KAB = knowledge, attitudes and behaviours. New Zealand includes New Zealand-Maori and New Zealand-European

This section examines the characteristics of each participant concerning school, gender, age and ethnicity (table 4). The total Year 9 population of the three colleges in Rarotonga is 173. Of these, 144 completed the health assessment, and 156 took part in the KAB survey. In total, 133 adolescents (48% males and 52% females) provided anthropometric and KAB data. Participants were predominantly Cook Islanders (72.3%) with the remainder being ‘New Zealand-Maori/New Zealand-European’ (22.5%), ‘Other Pacific’ (9.8%), or ‘Other’ (6.9%).

Profile of the anthropometric data

Table 5: Anthropometric measures of the participants by sex

Adolescent Health Indicator	Total	Males	Females	OR (Males vs Females)
Waist-to-height-ratio	n = 132	n = 63	n = 69	
% Low (< 0.5)	67.4	68.3	66.7	0.9 (95% CI: 0.449 - 1.929),
% Increased (> 0.5)	32.6	31.7	33.3	$\chi2(1) = 0.038$, p = 0.846
Body mass index	n = 133	n = 64	n = 69	
% Healthy (SD = 0)	35.6	35.9	35.3	0.9 (95% CI: 0.482 - 1.692),
% Overweight (> +1 SD)	31.1	34.4	27.9	$\chi2(1) = 0.101$, p = 0.751
% Obese/severely obese (> +2 SD)	33.3	29.7	36.8	
Blood pressure	n = 129	n = 63	n = 66	
% Normal (< 90th Percentile)	41.9	30.2	53.0	4.7 (95% CI: 1.474 – 15.406),
% Raised (> 90th Percentile)	58.1	69.8	47.0	$\chi2(1) = 6.805$, p = **0.009***
Total cholesterol	n = 129	n = 61	n = 68	
% Acceptable (< 4.4mmol/L)	86.0	77.0	94.1	0.2 (95% CI: 1.268 – 5.389),
% Borderline/High (> 4.4mmol/L)	14.0	23.0	5.9	$\chi2(1) = 6.783$, p = **0.009***
Low-density-lipoprotein	n = 102	n = 50	n = 52	
% Acceptable (< 2.8mmol/L)	89.2	84.0	94.2	2.7 (95% CI: 0.647 - 10.925),
% Borderline/High (> 2.8mmol/L)	10.8	16.0	5.8	$\chi2(1) = 1.840$, p = 0.175

The effect of gender on health were assessed using ordinal logistic regression with proportional odds. *Bold: significant (p < 0.05). OR = Odds Ratio

This section provides a brief overview of the participants' waist-to-height-ratio (WHtR), body mass index (BMI), blood pressure (BP), total cholesterol (TC) and low-density-lipoprotein (LDL) statuses (table 5). Majority of the participants are non-centrally obese (67.4%) and have acceptable LDL (89.2%) and TC (86.0%) levels. Despite this, there are still a significant number of the participants who are centrally obese (32.6%) and have borderline/high LDL (14.0%) and TC (10.8%) levels. In addition, a high proportion is overweight/obese (64.4%) and at greater risk of prehypertension/hypertension (58.1%). Boys were more likely to be at greater risk of prehypertension/hypertension compared to girls (OR = 4.7, p = 0.009). However, girls were more likely to have elevated TC compared to boys (OR = 0.2. p = 0.009).

Profile of the knowledge, attitudes and behaviour data

Knowledge about the life-course impact of nutrition and health

Table 6: Knowledge about nutrition & health across the life course

Knowledge	Total	Boys	Girls	OR (Male vs Female)
The food I eat now affects my health in the future	n = 130	n = 64	n = 66	
% Strongly agree	42.9	39.1	48.5	
% Agree	32.3	34.4	31.8	0.6 (95% CI: 0.336 - 1.207)
% I don't know	9.8	7.8	12.1	$\chi2(1) = 1.913$, p = 0.166
% Disagree	10.5	14.1	8.6	
% Strongly disagree	2.3	4.7	0.0	
It is important for me to eat healthy food now	n = 132	n = 64	n = 68	
% Strongly agree	85	81.3	89.7	
% Agree	12.8	17.2	8.8	0.5 (95% CI: 0.184 - 1.366)
% I don't know	0.8	0.0	1.5	$\chi2(1) = 1.822$, p = 0.177
% Disagree	0.6	0.0	0.0	
% Strongly disagree	0.8	1.6	0.0	
The food I eat now may affect the health of any children I have in the future	n = 132	n = 64	n = 68	
% Strongly agree	15.8	12.5	19.1	
% Agree	35.3	37.5	33.8	0.5 (95% CI: 0.159 - 1.528)
% I don't know	24.1	18.8	29.4	$\chi2(1) = 1.502$, p = 0.220
% Disagree	19.5	23.4	16.2	
% Strongly disagree	4.5	7.8	1.5	
The food a father eats affects the health of his children when they grow up	n = 132	n = 64	n = 68	
% Strongly agree	5.3	10.9	0.0	
% Agree	26.3	32.8	20.6	2.2 (95% CI: 0.693 - 6.709)
% I don't know	31.6	28.1	35.3	$\chi2(1) = 1.761$, p = 0.184
% Disagree	29.3	20.3	38.2	
% Strongly disagree	6.8	7.8	5.9	
The food a father eats affects the health of his children when they are babies	n = 132	n = 64	n = 68	
% Strongly agree	10.5	17.2	4.4	
% Agree	23.3	23.4	23.5	1.3 (95% CI: 0.729 - 2.487)
% I don't know	26.3	21.9	30.9	$\chi2(1) = 0.905$, p = 0.341
% Disagree	31.6	25	38.2	
% Strongly disagree	7.5	12.5	2.9	
The food a woman eats when she is pregnant affects the health of her baby when it is grown up	n = 132	n = 64	n = 68	
% Strongly agree	29.3	32.8	26.5	
% Agree	32.3	29.7	35.3	0.9 (95% CI: 0.287 - 2.698)
% I don't know	22.6	20.3	25.0	$\chi2(1) = 0.050$, 0.822
% Disagree	12.0	14.1	10.3	
% Strongly disagree	3.0	3.1	2.9	
The food a woman eats when is pregnant affects the health of her baby	n = 132	n = 64	n = 68	
% Strongly agree	57.1	54.7	60.3	
% Agree	22.6	20.3	25.0	0.7 (95% CI: 0.356 - 1.347)
% I don't know	15.0	17.2	13.2	$\chi2(1) = 1.170$, p = 0.279
% Disagree	3.8	6.3	1.5	
% Strongly disagree	0.8	1.6	0.0	

The effect of gender on responses was assessed using ordinal logistic regression with proportional odds. OR = Odds Ratio

At baseline, most of the participants strongly agree/agree (76.9%) that the food they eat now does affect their future health (table 6). However, when questioned how important it is to eat healthy food now, most strongly agreed (85.0%). This suggests that students have a higher level of awareness between eating healthy food now than links between nutrition and health.

Furthermore, at baseline, students have more awareness about the impact of personal and maternal nutrition on the later-life health outcomes of the offspring compare to the influences of paternal nutrition with no gender-related differences.

Attitudes towards health and wellbeing

Table 7: Attitudes to health and wellbeing

Statement	How much does it matter what you eat?			How much does it matter whether or not you are healthy?		
	Total	Male	Female	Total	Male	Female
Matched responses	n = 133	n = 64	n = 69	n = 128	n = 63	n = 67
% A lot	37.6	35.9	39.1	56.3	49.2	63.1
% Some	52.6	51.6	53.6	35.9	41.3	30.8
% Not very much	9.8	12.5	7.2	7.0	9.5	4.6
% Not at all	0.0	0.0	0.0	0.8	0.0	1.5
OR (Male cf. Female)	0.8			0.6		
95% CI	0.410 - 1.535			0.290 - 1.148		
$\chi 2(1)$	0.473			2.454		
p	0.491			0.117		

The effect of gender on responses was assessed using ordinal logistic regression with proportional odds. OR = Odds Ratio

At baseline, most of the participants place higher value towards being healthy (56.3%) compared to what they eat with no gender-related differences (table 7).

Food Behaviours

Protective foods

Table 8: Gender-based variance in participants within 'at risk' category for fruits and vegetables

Meal Pattern		Fresh fruit			Raw or salad vegetables			Cooked green vegetables		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
Matched Reponses		n = 133	n = 64	n = 69	n = 133	n = 64	n = 69	n = 133	n = 64	n = 69
% > 5 days per week		16.5	14.1	18.8	19.5	10.9	27.5	18.8	18.8	18.8
% 4 - 5 days per week		21.8	12.5	30.4	21.8	25.0	18.8	15.8	10.9	20.3
% 2 - 3 days per week		39.1	42.2	36.2	29.3	32.8	26.1	29.3	31.3	27.5
% 1 day per week		18.8	28.1	10.1	21.1	21.9	20.3	23.3	23.4	23.2
% Never		3.8	3.1	4.5	8.3	9.4	7.3	12.8	15.6	10.2
Responses in 'at risk' category	n	82			78			87		
	%	61.7			58.6			65.4		
OR (Male cf. Female)		2.6			1.5			1.5		
95% CI		1.296 – 5.564			0.769 – 3.093			0.740 – 3.134		
$\chi 2(1)$		7.068			1.486			1.302		
p		**0.008***			0.223			0.254		

The effect of gender on responses was assessed using binomial logistic regression with proportional odds. *Bold significant ($p < 0.05$). OR = Odds Ratio

Overall, pre-intervention, 38.3% of the participants met the guideline for fruit, 41.4% met the guideline for raw or salad vegetable intake, and 34.6% met the guideline for cooked green vegetables (table 8). Boys were 2.6 times more likely than girls to not meet the guideline (> 3 days per week) for fruit intake ($p = 0.008$).

High-fat foods

Table 8: Gender-based variance in participants within the 'at risk' category for high-fat foods

Meal Pattern		Doughnuts			Hot Chips (Fries)			Meat Pies/Sausage Rolls		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
Matched Responses		n = 133	n = 64	n = 69	n = 132	n = 63	n = 69	n = 133	n = 64	n = 69
% > 5 days per week		10.5	12.5	8.7	11.4	9.5	13.0	8.3	9.4	7.2
% 4 - 5 days per week		18.0	23.4	13.0	12.1	14.3	10.1	8.3	9.4	7.2
% 2 - 3 days per week		23.3	25.0	21.7	32.6	33.3	31.9	27.8	35.9	20.3
% 1 day per week		33.1	32.8	33.3	37.1	39.7	34.8	39.8	37.5	42.0
% Never		15.1	6.3	23.1	6.8	3.2	10.2	15.8	7.8	23.3
Responses in 'at risk' category	n	69			74			53		
	%	51.9			56.1			39.8		
OR (Male cf. Female)		2.0			1.1			2.3		
95% CI		1.015 - 4.051			0.546 - 2.165			1.126 - 4.549		
$\chi 2(1)$		1.399			0.057			5.254		
p		**0.045***			0.811			**0.022***		

The effect of gender on responses was assessed using binomial logistic regression with proportional odds. *Bold: significant ($p < 0.05$). OR = Odds Ratio

At baseline, over half of the participants ate doughnuts (51.9%) and hot chips (56.1%) more than one day per week (table 9). Fewer adolescents (39.8%) ate meat pies or sausage rolls

more than one day per week. Boys were more likely than girls to eat meat pies or sausage rolls (OR = 2.3, p = 0.022) and doughnuts (OR = 2.0, p = 0.045) more than one day per week.

Regular fizzy or soft drink

Table 9: Gender-based variance in participants within the 'at risk' category for regular fizzy or soft drinks

Meal Pattern		Regular Fizzy/Soft drinks		
		Total	**Male**	**Female**
Matched Responses		n = 131	n = 63	n = 68
% > 5 days per week		16.8	14.3	19.1
% 4 - 5 days per week		16.0	19.0	13.2
% 2 - 3 days per week		38.9	42.9	35.3
% 1 day per week		23.7	22.2	25.0
% Never		4.6	1.6	7.4
Responses in 'at risk' category	n	94		
	%	71.8		
OR (Male cf. Female)		1.5		
95% CI		0.708 - 3.308		
$\chi 2(1)$		1.171		
p		0.279		

The effect of gender on health were assessed using binomial logistic regression with proportional odds. OR = Odds Ratio

At baseline, 71.8% of adolescents drank regular fizzy or soft drinks more than once a week, with no gender-related differences (table 10).

Breakfast and high-fat takeaway meal pattern

Table 10: Gender-based variance in participants within the 'at risk' category for breakfast and high-fat takeaway meal patterns

Meal Pattern		Breakfast			High-fat takeaway foods		
		Total	**Male**	**Female**	**Total**	**Male**	**Female**
Matched Responses		n = 132	n = 63	n = 69	n = 133	n = 64	n = 69
% > 5 days per week		27.8	29.7	26.1	27.8	29.7	26.1
% 4 - 5 days per week		19.5	29.7	10.1	19.5	29.7	10.1
% 2 - 3 days per week		35.3	26.6	43.5	35.3	26.6	43.5
% 1 day per week		9.8	6.3	13.0	9.8	6.3	13.0
% Never		7.5	7.8	7.2	7.6	7.7	7.1
Responses in 'at risk' category	n	106			110		
	%	80.3			82.7		
OR (Male cf. Female)		2.4			0.7		
95% CI		0.193 - 0.783			0.144 - 3.120		
$\chi 2(1)$		7.001			0.260		
p		**0.008***			0.610		

The effect of gender on responses was assessed using binomial logistic regression with proportional odds. *Bold: significant (p < 0.05). OR = Odds Ratio

At baseline, 80.3% adolescents said they usually have breakfast less than five days per week (table 11). A further 82.7% ate high-fat takeaway foods more than one day per week. Boys were more likely than girls to have breakfast less than five days per week (OR = 2.4, p = 0.008).

Association between anthropometric and knowledge, attitudes and behaviours

Association between waist-to-height-ratio and knowledge, attitudes and behaviours

Table 11: Association between waist-to-height-ratio and knowledge, attitudes and behaviours

	Statements	Low WHtR	Increased WHtR	OR (Increased WHtR vs Low WHtR)
Knowledge	**The food I eat now affect my health in the future**	n = 87	n = 42	
	% Strongly agree	43.7	42.9	1.0 (95% CI: 0.483 - 1.885)
	% Agree	32.2	35.7	$\chi2(1) = 0.018$, p = 0.892
	% I don't know	10.3	9.5	
	% Disagree	10.3	11.9	
	% Strongly disagree	3.5	0.0	
	It is important for me to eat healthy food now	n = 89	n = 42	
	% Strongly agree	86.5	81.4	
	% Agree	11.2	16.3	1.2 (95% CI: 0.450 - 3.437)
	% I don't know	1.1	2.3	$\chi2(1) = 0.178$, p = 0.674
	% Disagree	0.0	0.0	
	% Strongly disagree	1.2	0.0	
	The food I eat now may affect the health of any children I have in the future	n = 88	n = 43	
	% Strongly agree	14.8	18.6	
	% Agree	34.1	39.5	1.2 (95% CI: 0.831 - 1.791)
	% I don't know	26.1	20.9	$\chi2(1) = 1.027$, p = 0.311
	% Disagree	19.3	18.6	
	% Strongly disagree	5.7	2.3	
	The food a father eats affects the health of his children when it is grown up	n = 88	n = 43	
	% Strongly agree	5.7	2.3	
	% Agree	26.1	27.9	0.8 (95% CI: 0.555 - 1.196)
	% I don't know	36.4	23.3	$\chi2(1) = 1.092$, p = 0.296
	% Disagree	25.0	39.5	
	% Strongly disagree	6.8	7.0	
	The food a father eats affects the health of his children they are babies	n = 88	n = 43	
	% Strongly agree	12.5	7.0	
	% Agree	20.5	27.9	1.2 (95% CI: 0.583 - 2.433)
	% I don't know	28.4	23.3	$\chi2(1) = 0.229$, p = 0.632
	% Disagree	28.4	39.5	
	% Strongly disagree	10.2	2.3	
	The food a woman eats when she is pregnant affects the health of her baby when it is grown up	n = 88	n = 43	
	% Strongly agree	31.8	23.3	
	% Agree	26.1	46.5	1.0 (95% CI: 0.672 - 1.459)
	% I don't know	26.1	16.3	$\chi2(1) = 0.003$, p = 0.960
	% Disagree	13.6	9.3	
	% Strongly disagree	2.3	4.7	
	7. The food a woman eats when she is pregnant affects the health of her baby	n = 88	n = 43	
	% Strongly agree	55.7	0.0	
	% Agree	23.9	4.7	1.0 (95% CI: 0.526 - 1.943)
	% I don't know	15.9	14.0	$\chi2(1) = 0.001$, p = 0.974
	% Disagree	3.4	20.9	
	% Strongly disagree	1.1	60.5	
Attitudes	**How much does it matter what you eat?**	n = 89	n = 43	
	% A lot	41.6	30.2	
	% Some	49.4	58.1	1.6 (95% CI: 0.766 - 3.176)
	% Not very much	9.0	11.7	$\chi2(1) = 1.504$, p = 0.220
	% Not at all	0.0	0.0	
	How much does it matter whether or not you are healthy?	n = 85	n = 42	
	% A lot	54.1	59.5	
	% Some	34.1	40.5	0.7 (95% CI: 0.324 - 1.424)
	% Not very much	10.6	0.0	$\chi2(1) = 1.050$, p = 0.306
	% Not at all	1.2	0.0	

The effect of waist-to-height-ratio on knowledge and attitudes were assessed using ordinal logistic regression with proportional odds. OR = Odds Ratio. WHtR = waist-to-height-ratio

Table 12 1: Association between waist-to-height-ratio and knowledge, attitudes and behaviours (continue)

	Statements	Low WHtR	Increased WHtR	Responses in 'at risk' category				OR (Increased WHtR vs Low WHtR) 'at risk'
				Low WHtR		Increased WHtR		
				n	%	n	%	
Behaviours	**Fresh fruit**	n = 89	n = 43					
	% > 5 days per week	12.4	25.6					
	% 4 - 5 days per week	21.3	23.3					1.9 (95% CI: 0.894 - 3.493)
	% 2 - 3 days per week	39.3	37.2	59	66.2	22	51.2	χ2(1) = 2.767, p = 0.096
	% 1 day per week	22.5	11.6					
	% Never	4.5	2.3					
	Raw or salad vegetables	n = 89	n = 43					
	% > 5 days per week	18.0	23.3					
	% 4 - 5 days per week	22.5	20.9					1.2 (95% CI: 0.558 - 2.433)
	% 2 - 3 days per week	27.0	34.8	53	59.6	27	55.8	χ2(1) = 0.166, P = 0.683
	% 1 day per week	23.5	14.0					
	% Never	9.0	7.0					
	Cooked green vegetables	n = 89	n = 43					
	% > 5 days per week	18.0	20.9					1.4 (95% CI: 0.636 - 2.879)
	% 4 - 5 days per week	14.6	18.6					χ2(1) = 0.615, p = 0.433
	% 2 - 3 days per week	30.3	27.9	60	67.4	26	60.5	
	% 1 day per week	24.7	18.6					
	% Never	12.4	14.0					
	Doughnuts	n = 89	n = 43					
	% > 5 days per week	11.2	9.3					1.2 (95% CI: 0.592 - 2.542)
	% 4 - 5 days per week	21.3	11.6					χ2(1) = 0.301, p = 0.583
	% 2 - 3 days per week	21.3	27.9	48	53.9	21	48.8	
	% 1 day per week	31.5	34.9					
	% Never	14.6	16.3					
	Hot chips (Fries)	n = 88	n = 43					
	% > 5 days per week	13.6	7.0					0.9 (95% CI: 0.433 - 1.891)
	% 4 - 5 days per week	11.4	14.0					χ2(1) = 0.071, p = 0.790
	% 2 - 3 days per week	30.7	37.2	49	55.7	25	58.1	
	% 1 day per week	37.5	34.9					
	% Never	6.8	7.0					
	Meat pies/sausage rolls	n = 89	n = 43					
	% > 5 days per week	10.1	4.7					0.7 (95% CI: 0.327 - 1.412)
	% 4 - 5 days per week	7.9	9.3					χ2(1) = 1.074, p = 0.300
	% 2 - 3 days per week	23.6	37.2	37	41.6	22	51.2	
	% 1 day per week	38.2	41.9					
	% Never	20.2	7.0					
	Regular fizzy/soft drinks	n = 88	n = 42					
	% > 5 days per week	18.2	14.3					0.7 (95% CI: 0.304 - 1.639)
	% 4 - 5 days per week	18.6	11.9					χ2(1) = 0.656, p = 0.418
	% 2 - 3 days per week	33.0	50.0	60	68.2	32	76.2	
	% 1 day per week	23.9	23.8					
	% Never	6.8	0.0					
	Breakfast	n = 88	n = 42					
	% > 5 days per week	32.6	18.6					1.1 (95% CI: 0.539 - 2.316)
	% 4 - 5 days per week	13.5	30.2					χ2(1) = 0.089, p = 0.765
	% 2 - 3 days per week	37.1	32.6	48	53.9	22	51.2	
	% 1 day per week	9.0	11.6					
	% Never	7.9	7.0					
	High-fat takeaway foods	n = 89	n = 42					
	% > 5 days per week	3.4	2.4					0.3 (95% CI: 0.039 - 2.896)
	% 4 - 5 days per week	16.9	16.7					χ2(1) = 0.981, 0.322
	% 2 - 3 days per week	73.0	78.6	83	93.3	41	97.6	
	% 1 day per week	6.7	2.4					
	% Never	0.0	0.0					

The effect of waist-to-height-ratio on behaviour was assessed using binomial logistic regression with proportional odds. OR = Odds Ratio

Table 12 highlights the association found between WHtR and health-related KAB. While many of the KAB variables were examined in relation to WHtR, there were no apparent relationships establish in relation to risk for central obesity. Table 10 shows there was a clear, sharp trend towards a positive association between central obesity and low intake of fruit (< 3 days per week). However, this was not significant ($p = 0.096$). This suggests that inadequate levels of KAB are not linked to increased risk for central obesity and thus NCD risk factors in adolescence.

Association between body mass index and knowledge, attitudes and behaviours

Table 12: Association between body mass index and knowledge, attitudes and behaviours

	Statements	Health	Overweight	Obese/severely obese	OR (Obese/severely vs Healthy)	OR (Overweight vs Healthy)
Knowledge	**The food I eat now affect my health in the future**	n = 46	n = 39	n = 44		
	% Strongly agree	43.5	48.7	40.9		
	% Agree	34.8	30.8	34.1	0.9 (95% CI: 0.414 - 1.900)	1.2 (95% CI: 0.540 - 2.648)
	% I don't know	8.7	10.3	11.4	$\chi2(1) = 0.096$, p = 0.757	$\chi2(1) = 0.193$, p = 0.660
	% Disagree	10.9	7.7	11.4		
	% Strongly disagree	2.1	2.5	2.2		
	It is important for me to eat healthy food now	n = 47	n = 41	n = 43		
	% Strongly agree	91.5	82.9	79.5		
	% Agree	8.5	14.6	15.9	0.4 (95% CI: 0.112 - 1.450)	0.4 (95% CI: 0.120 - 1.642)
	% I don't know	0.0	0.0	4.6	$\chi2(1) = 1.936$, p = 0.164	$\chi2(1) = 1.481$, 0.224
	% Disagree	0.0	0.0	0.0		
	% Strongly disagree	0.0	2.5	0.0		
	The food I eat now may affect the health of any children I have in the future	n =47	n = 41	n = 43		
	% Strongly agree	14.9	22.0	11.6	1.0 (95% CI: 0.471 - 2.082)	0.9 (95% CI: 0.409 - 1.858)
	% Agree	40.4	26.8	39.5	$\chi2(1) = 0.001$, p = 0.979	$\chi2(1) = 0.126$, p = 0.722
	% I don't know	21.3	19.5	30.2		
	% Disagree	19.1	24.4	16.3		
	% Strongly disagree	4.3	7.3	2.3		
	The food a father eats affects the health of his children when it is grown up	n =47	n = 41	n = 43		
	% Strongly agree	4.3	4.9	7.0	0.7 (95% CI: 0.320 - 1.430)	0.8 (95% CI: 0.393 - 1.794)
	% Agree	36.2	24.4	18.6	$\chi2(1) = 1.047$, p = 0.306	$\chi2(1) = 0.204$, p = 0.652
	% I don't know	23.4	36.6	34.9		
	% Disagree	27.7	29.3	32.6		
	% Strongly disagree	8.5	4.9	7.0		
	The food a father eats affects the health of his children they are babies	n =47	n = 41	n = 43		
	% Strongly agree	12.8	7.3	11.6		
	% Agree	29.8	26.8	14.0	0.7 (95% CI: 0.348 - 1.533)	0.6 (95% CI: 0.272 - 1.243)
	% I don't know	23.4	19.5	34.9	$\chi2(1) = 0.690$, p = 0.406	$\chi2(1) = 1.959$, p = 0.162
	% Disagree	29.8	31.7	34.9		
	% Strongly disagree	4.3	14.6	4.7		
	The food a woman eats when she is pregnant affects the health of her baby when it is grown up	n =47	n = 41	n = 43		
	% Strongly agree	25.5	34.1	27.9	0.8 (95% CI: 0.386 - 1.706)	1.2 (95% CI: 0.544 - 2.487)
	% Agree	42.6	31.7	23.3	$\chi2(1) = 0.305$, p = 0.581	$\chi2(1) = 0.152$, p = 0.697
	% I don't know	17.0	17.1	34.9		
	% Disagree	8.5	17.0	11.6		
	% Strongly disagree	6.4	0.0	2.3		
	The food a woman eats when she is pregnant affects the health of her baby	n =47	n = 41	n = 43		
	% Strongly agree	66.0	56.1	51.2		
	% Agree	14.9	22.0	30.2	0.7 (95% CI: 0.302 - 1.544)	0.7 (95% CI: 0.295 - 1.553)
	% I don't know	17.0	12.2	16.3	$\chi2(1) = 0.841$, p = 0.359	$\chi2(1) = 0.847$, p = 0.357
	% Disagree	2.1	7.3	2.3		
	% Strongly disagree	0.0	2.4	0.0		
Attitudes	**How much does it matter what you eat?**	n = 47	n = 41	n = 44		
	% A lot	25.5	48.8	38.6	2.0 (95% CI: 0.895 - 4.569)	2.6 (95% CI: 1.120 - 5.954)
	% Some	59.6	41.5	56.8	$\chi2(1) = 2.863$, 0.091	$\chi2(1) = 4.959$, **p = 0.026***
	% Not very much	14.9	9.7	4.6		
	% Not at all	0.0	0.0	0.0		
	How much does it matter whether or not you are healthy?	n = 46	n = 39	n = 42		
	% A lot	56.5	61.5	52.4	0.9 (95% CI: 0.381 - 1.959)	1.1 (95% CI: 0.488 - 2.667)
	% Some	37.0	28.2	40.5	$\chi2(1) = 0.124$, 0.725	$\chi2(1) = 0.092$, p = 0.761
	% Not very much	4.3	10.3	7.1		
	% Not at all	2.2	0.0	0.0		

The effect of body mass index on knowledge and attitudes were assessed using ordinal logistic regression with proportional odds. *Bold: significant ($p < 0.05$), OR = Odds Ratio.

Table 13 1: Association between body mass index and knowledge, attitudes and behaviours (continue)

	Statements	Healthy	Overweight	Obese/severely obese	Responses in 'at risk' category						OR (Obese/severely vs Healthy) 'at risk'	OR (Overweight vs Healthy) 'at risk'
					Healthy		Overweight		Obese/severely obese			
					n	%	n	%	n	%		
Behaviours	**Fresh fruit**	n = 47	n = 41	n = 44								
	% > 5 days per week	21.3	19.5	9.1								
	% 4 - 5 days per week	19.1	24.4	20.5							1.6 (95% CI: 0.677 - 3.867)	0.9 (95% CI: 0.371 - 2.025)
	% 2 - 3 days per week	27.7	43.9	47.7	29	61.7	23	56.1	30	68.2	$\chi2(1) = 1.173$, p = 0.279	$\chi2(1) = 0.109$, p = 0.867
	% 1 day per week	27.7	9.8	18.2								
	% Never	4.2	2.4	4.5								
	Raw or salad vegetables	n = 47	n = 41	n = 44								
	% > 5 days per week	25.5	19.5	13.6								
	% 4 - 5 days per week	17.0	24.4	22.7							1.3 (95% CI: 0.558 - 3.013)	0.9 (95% CI: 0.406 - 2.204)
	% 2 - 3 days per week	29.8	26.8	31.8	28	59.6	23	56.1	27	61.4	$\chi2(1) = 0.364$, P = 0.547	$\chi2(1) = 0.406 - 2.204$
	% 1 day per week	19.1	22.0	22.7								
	% Never	8.6	7.3	9.2								
	Cooked green vegetables	n = 47	n = 41	n = 44								
	% > 5 days per week	23.4	24.4	9.1							0.8 (95% CI: 0.333 - 2.016)	0.4 (95% CI: 0.183 - 1.074)
	% 4 - 5 days per week	4.3	22.0	22.7							$\chi2(1) = 0.188$, p = 0.664	$\chi2(1) = 3.248$, p = 0.072
	% 2 - 3 days per week	38.3	17.1	31.8	34	72.3	22	53.7	30	68.2		
	% 1 day per week	25.5	22.0	20.5								
	% Never	8.5	14.5	15.9								
	Doughnuts	n = 47	n = 41	n = 44								
	% > 5 days per week	10.6	12.2	9.1							0.5 (95% CI: 0.220 - 1.173)	1.4 (95% CI: 0.594 - 3.299)
	% 4 - 5 days per week	21.3	24.4	9.1							$\chi2(1) = 2.513$, p = 0.113	$\chi2(1) = 0.592$, 0.442
	% 2 - 3 days per week	23.4	26.8	20.5	26	55.3	26	63.4	17	38.6		
	% 1 day per week	34.0	22.0	40.9								
	% Never	10.7	14.6	20.4								
	Hot chips (Fries)	n = 47	n = 40	n = 44								
	% > 5 days per week	12.8	12.5	6.8							1.0 (95% CI: 0.425 - 2.237)	0.8 (95% CI: 0.351 - 0.912)
	% 4 - 5 days per week	12.8	7.5	15.5							$\chi2(1) = 0.004$, p = 0.952	$\chi2(1) = 0.214$, p = 0.644
	% 2 - 3 days per week	31.9	32.5	34.1	27	57.4	21	52.5	25	56.8		
	% 1 day per week	34.0	42.5	36.8								
	% Never	8.5	5.0	6.8								
	Meat pies/sausage rolls	n = 47	n = 40	n = 44								
	% > 5 days per week	12.8	2.4	9.1							1.0 (95% CI: 0.455 - 2.364)	0.7 (95% CI: 0.279 - 1.543)
	% 4 - 5 days per week	10.6	7.3	4.5							$\chi2(1) = 0.008$, p = 0.930	$\chi2(1) = 0.935$, p = 0.333
	% 2 - 3 days per week	23.4	26.8	34.1	23	48.9	15	37.5	20	45.5		
	% 1 day per week	38.3	43.9	38.6								
	% Never	14.9	19.6	13.7								

The effect of body mass index on behaviour was assessed using ordinal logistic regression with proportional odds. OR = Odds Ratio.

Table 13 2: Association between body mass index and knowledge, attitudes and behaviours (continue)

	Statements	Healthy	Overweight	Obese/severely obese	Responses in 'at risk' category						OR (Obese/severely vs Healthy) 'at risk'	OR (Overweight vs Healthy) 'at risk'
					Healthy		Overweight		Obese/severely obese			
					n	%	n	%	n	%		
Behaviours	**Regular fizzy/soft drinks**	n = 48	n = 40	n = 42								
	% > 5 days per week	17.0	15.0	18.6							2.7 (95% CI: 0.967 - 7.286)	1.0 (95% CI: 0.395 - 2.326)
	% 4 - 5 days per week	14.9	10.0	23.3							$\chi2(1) = 3.591$, **p = 0.058***	$\chi2(1) = 0.009$, p = 0.925
	% 2 - 3 days per week	34.0	40.0	41.9	31	64.6	26	65	36	85.7		
	% 1 day per week	31.9	25.0	14.0								
	% Never	2.2	10.0	2.2								
	Breakfast	n = 47	n = 41	n = 44								
	% > 5 days per week	36.2	29.3	18.2	23	48.9	22	53.7	24	54.4	1.5 (95% CI: 0.654 - 3.419)	1.3 (95% CI: 0.568 - 3.047)
	% 4 - 5 days per week	17.0	17.1	25.0							$\chi2(1) = 0.909$, p = 0.340	$\chi2(1) = 0.410$. p = 0.522
	% 2 - 3 days per week	27.7	41.5	36.4								
	% 1 day per week	10.6	7.3	11.4								
	% Never	8.5	4.8	9.0								
	High-fat takeaway foods	n = 47	n = 40	n = 44								
	% > 5 days per week	6.4	7.5	6.8	35	74.5	36	90	43	97.7	1.5 (95% CI: 0.620 - 3.684)	0.9 (95% CI: 0.357 - 2.026)
	% 4 - 5 days per week	19.1	10.0	9.1							$\chi2(1) = 824$, p = 0.364	$\chi2(1) = 0.135$, p = 0.714
	% 2 - 3 days per week	38.3	42.5	56.8								
	% 1 day per week	29.8	30.0	27.3								
	% Never	6.4	10.0	0.0								

The effect of body mass index on behaviour was assessed using ordinal logistic regression with proportional odds. *Bold: significant ($p < 0.05$). OR = Odds Ratio.

Table 13 shows the association found between adolescent BMI and health-related KAB. One of the critical relationships found was related to the participants' behaviour towards sugar-sweetened beverage. Overweight students are 2.7 times more likely to consume regular fizzy or soft drinks more than one day per week compared to their healthy weight counterparts ($p = 0.058$). This indicates that fizzy or soft drink is associated with overweight in adolescents. Interestingly table 13 also shows that obese/severely obese adolescents are 2.6 times more likely to consider what they eat matters a lot compared to those of healthy weight ($p = 0.026$). This shows that obese/severely obese adolescents are aware of the importance of nutrition compared to students of healthy weight. There was a trend towards positive associations between overweight and low consumption of cooked green vegetable (< 3 days per week). However, this was not significant ($p = 0.072$). There were no associations found between BMI and health-related knowledge. Therefore this suggests that poor health-knowledge is not linked to overweight/obesity in adolescents.

Associations between blood pressure and knowledge, attitudes and behaviours

Table 13: Association between blood pressure and knowledge, attitudes and behaviours

	Statements	Normal BP	Raised BP	OR (Raised BP vs Normal BP)
Knowledge	**The food I eat now affect my health in the future**	n = 53	n = 73	
	% Strongly agree	49.1	39.7	0.7 (95% CI: 0.367 - 1.368)
	% Agree	30.2	34.2	$\chi2(1) = 1.057$, p = 0.304
	% I don't know	7.5	12.3	
	% Disagree	13.2	9.6	
	% Strongly disagree	0.0	4.2	
	It is important for me to eat healthy food now	n = 54	n = 74	
	% Strongly agree	94.4	79.7	
	% Agree	5.6	18.9	4.6 (95% CI: 1.271 - 16.728)
	% I don't know	0.0	1.4	$\chi2(1) = 5.402$, **p = 0.020***
	% Disagree	0.0	0.0	
	% Strongly disagree	0.0	0.0	
	The food I eat now may affect the health of any children I have in the future	n = 54	n = 74	
	% Strongly agree	20.4	13.5	
	% Agree	40.7	29.7	0.5 (95% CI: 0.267 - 0.961)
	% I don't know	22.2	27.0	$\chi2(1) = 4.331$, **p = 0.037***
	% Disagree	14.8	24.3	
	% Strongly disagree	1.9	5.4	
	The food a father eats affects the health of his children when it is grown up	n = 54	n = 74	
	% Strongly agree	1.9	8.1	
	% Agree	31.5	23.0	1.1 (95% CI: 0.570 - 2.022)
	% I don't know	25.9	35.0	$\chi2(1) = 0.049$, p = 0.826
	% Disagree	38.9	24.3	
	% Strongly disagree	1.9	9.5	
	The food a father eats affects the health of his children they are babies	n = 54	n = 74	
	% Strongly agree	7.4	12.2	
	% Agree	27.8	21.6	0.9 (95% CI: 0.498 - 1.753)
	% I don't know	27.8	25.7	$\chi2(1) = 0.045$, p = 0.833
	% Disagree	31.5	32.4	
	% Strongly disagree	5.6	8.1	
	The food a woman eats when she is pregnant affects the health of her baby when it is grown up	n = 54	n = 74	
	% Strongly agree	37.0	24.3	
	% Agree	38.9	29.7	0.5 (95% CI: 0.238 - 0.871)
	% I don't know	14.8	28.4	$\chi2(1) = 5.654$, **p = 0.017***
	% Disagree	9.0	13.5	
	% Strongly disagree	0.0	4.1	
	The food a woman eats when she is pregnant affects the health of her baby	n = 54	n = 74	
	% Strongly agree	64.8	51.4	
	% Agree	24.1	23.0	0.5 (95% CI: 0.256 - 1.037)
	% I don't know	9.3	18.9	$\chi2(1) = 3.450$, p = 0.063
	% Disagree	1.9	5.4	
	% Strongly disagree	0.0	1.4	
Attitudes	**How much does it matter what you eat?**	n = 54	n = 75	
	% A lot	44.4	30.7	
	% Some	50.0	57.3	0.5 (95% CI: 0.266 - 1.058)
	% Not very much	5.6	12.0	$\chi2(1) = 3.242$, p = 0.072
	% Not at all	0.0	0.0	
	How much does it matter whether or not you are healthy?	n = 53	n = 71	
	% A lot	60.4	53.5	
	% Some	35.8	36.6	0.7 (95% CI: 0.349 - 1.439)
	% Not very much	1.9	9.9	$\chi2(1) = 0.907$, p = 0.341
	% Not at all	1.9	0.0	

The effect of blood pressure on knowledge and attitudes were assessed using ordinal logistic regression with proportional odds. *Bold: significant ($p < 0.05$), OR = Odds Ratio.

Table 14 1: Association between blood pressure and knowledge, attitudes and behaviours (continue)

	Statements	Normal BP	Raised BP	Responses in 'at risk' category				OR (Raised BP vs Normal BP) 'at risk'
				Normal BP		Raised BP		
				n	%	n	%	
Behaviours	**Fresh fruit**	n = 54	n = 75					
	% > 5 days per week	24.1	10.7					
	% 4 - 5 days per week	27.8	18.7					2.6 (95% CI: 1.251 - 5.380)
	% 2 - 3 days per week	29.6	46.7	26	48.1	53	70.7	$\chi2(1) = 6.562$, **p = 0.010***
	% 1 day per week	11.1	22.7					
	% Never	7.4	1.2					
	Raw or salad vegetables	n = 54	n = 75					
	% > 5 days per week	27.8	13.3					
	% 4 - 5 days per week	18.5	24.0					1.5 (95% CI: 0.711 - 2.945)
	% 2 - 3 days per week	27.8	32.0	28	51.9	47	62.7	$\chi2(1) = 1.039$, P = 0.308
	% 1 day per week	16.7	24.0					
	% Never	9.2	6.7					
	Cooked green vegetables	n = 54	n = 75					
	% > 5 days per week	24.1	14.7					1.8 (95% CI: 0.858 - 3.722)
	% 4 - 5 days per week	18.5	14.7					$\chi2(1) = 2.408$, p = 0.121
	% 2 - 3 days per week	27.8	30.7	31	57.4	63	84.0	
	% 1 day per week	18.5	26.7					
	% Never	11.1	13.2					
	Doughnuts	n = 54	n = 75					
	% > 5 days per week	16.7	5.3					0.6 (95% CI: 0.297 - 1.220)
	% 4 - 5 days per week	18.5	17.3					$\chi2(1) = 1.983$, p = 0.159
	% 2 - 3 days per week	24.1	24.0	32	59.3	35	46.7	
	% 1 day per week	24.1	40.0					
	% Never	16.6	13.4					
	Hot chips (Fries)	n = 54	n = 75					
	% > 5 days per week	16.7	6.7					1.0 (95% CI: 0.477 - 1.949)
	% 4 - 5 days per week	13.0	12.0					$\chi2(1) = 0.010$, P = 0.920
	% 2 - 3 days per week	25.9	36.0	30	55.6	41	54.7	
	% 1 day per week	38.9	37.3					
	% Never	5.5	8.0					
	Meat pies/sausage rolls	n = 54	n = 75					
	% > 5 days per week	7.4	8.0					0.9 (95% CI: 0.434 - 1.785)
	% 4 - 5 days per week	9.3	6.7					$\chi2(1) = 0.124$, p = 0.725
	% 2 - 3 days per week	27.8	26.7	24	44.4	31	41.3	
	% 1 day per week	35.2	45.3					
	% Never	20.3	13.3					
	Regular fizzy/soft drinks	n = 52	n = 77					
	% > 5 days per week	19.2	13.3					1.4 (95% CI: 0.657 - 3.119)
	% 4 - 5 days per week	11.5	20.0					$\chi2(1) = 0.815$, p = 0.367
	% 2 - 3 days per week	36.7	41.3	35	67.3	56	72.7	
	% 1 day per week	28.8	20.7					
	% Never	3.8	4.7					
	Breakfast	n = 54	n = 75					
	% > 5 days per week	29.6	26.7					0.9 (95% CI: 0.439 - 1.784)
	% 4 - 5 days per week	16.7	22.7					$\chi2(1) = 0.116$, p = 0.733
	% 2 - 3 days per week	35.2	34.7	29	53.7	38	50.7	
	% 1 day per week	7.4	10.7					
	% Never	11.1	5.3					
	High-fat takeaway foods	n = 54	n = 74					
	% > 5 days per week	3.7	2.7					1.9 (95% CI: 0.406 - 8.832)
	% 4 - 5 days per week	27.8	8.1					$\chi2(1) = 0.660$, 0.417
	% 2 - 3 days per week	61.1	85.1	50	92.6	71	95.9	
	% 1 day per week	7.4	4.1					
	% Never	0.0	0.0					

The effect of blood pressure on knowledge and attitudes were assessed using binomial logistic regression with proportional odds. *Bold: significant ($p < 0.05$), OR = Odds Ratio.

Table 14 demonstrates the several associations found between adolescent BP and health-related KAB. It emphasizes that participants who have raised BP were 4.6 times more likely to have better knowledge on the importance of eating healthy food now compared to those with normal BP ($p = 0.020$). This indicates that adolescents at higher risk of prehypertension/ hypertension do understand the importance of nutrition. However, this study found that adolescents with raised BP are 2.6 times more likely to not meet the guideline for fruit intake per week (> 4 days per week) compared to those with normal BP ($p = 0.010$). This suggests that despite knowing the importance of nutrition, it does not seem to encourage more fruit consumption. Therefore, there could be other factors that require further investigation that's affecting the high BP among the participants in this study.

In addition, adolescents with normal BP are more likely to have awareness between the impacts of personal ($p = 0.037$) and maternal ($p = 0.017$) nutritional environment on the health outcome of the offspring later in life compared to those with raised BP. This level of awareness is much more critical for students with raised BP to be aware of compared to students with normal BP, as scientific evidence from DOHaD studies indicates that the disease trait is transgenerational in nature. There were trends towards positive associations between students who have raised BP and link between; maternal nutritional environment and health outcome of offspring ($p = 0.063$); and importance of nutrition ($p = 0.072$), however, they were not significant.

Associations between total cholesterol and knowledge, attitudes and behaviours

Table 14: Association between total cholesterol and knowledge, attitudes and behaviours

	Statements	Acceptable TC	Borderline/High TC	OR (Borderline/High TC vs Acceptable TC)
Knowledge	**The food I eat now affect my health in the future**	n = 108	n = 18	
	% Strongly agree	45.4	27.8	0.5 (95% CI: 0192 - 1.188)
	% Agree	33.3	38.9	$\chi2(1) = 2.527$, p = 0.112
	% I don't know	10.2	5.6	
	% Disagree	8.3	27.7	
	% Strongly disagree	2.8	0.0	
	It is important for me to eat healthy food now	n = 110	n = 18	
	% Strongly agree	87.3	77.8	
	% Agree	11.8	22.2	0.5 (95% CI: 0.159 - 1.885)
	% I don't know	0.9	0.0	$\chi2(1) = 0.914$, p = 0.547
	% Disagree	0.0	0.0	
	% Strongly disagree	0.0	0.0	
	The food I eat now may affect the health of any children I have in the future	n = 108	n = 8	
	% Strongly agree	19.1	0.0	
	% Agree	37.3	22.2	0.3 (95% CI: 0.122 - 0.762)
	% I don't know	22.7	33.3	$\chi2(1) = 6.456$, **p = 0.011***
	% Disagree	16.4	44.4	
	% Strongly disagree	4.5	0.0	
	The food a father eats affects the health of his children when it is grown up	n = 110	n = 18	
	% Strongly agree	5.5	5.6	
	% Agree	24.5	33.3	1.6 (95% CI: 0.649 - 3.943)
	% I don't know	30.9	33.3	$\chi2(1) = 1.044$, p = 0.307
	% Disagree	30.9	27.8	
	% Strongly disagree	8.2	0.0	
	The food a father eats affects the health of his children they are babies	n = 110	n = 18	
	% Strongly agree	10.9	11.1	
	% Agree	23.6	22.2	1.1 (95% CI: 0.446 - 2.658)
	% I don't know	26.4	27.8	$\chi2(1) = 0.035$, p = 0.852
	% Disagree	30.9	38.9	
	% Strongly disagree	8.2	0.0	
	The food a woman eats when she is pregnant affects the health of her baby when it is grown up	n = 110	n = 18	
	% Strongly agree	30	27.8	
	% Agree	33.6	27.8	0.8 (95% CI: 0.336 - 2.012)
	% I don't know	21.8	27.8	$\chi2(1) = 0.185$, p = 0.668
	% Disagree	10.9	16.7	
	% Strongly disagree	3.6	0.0	
	The food a woman eats when she is pregnant affects the health of her baby	n = 110	n = 18	
	% Strongly agree	60.0	50.0	
	% Agree	20.9	33.3	0.8 (95% CI: 0.297 - 1.995)
	% I don't know	14.5	11.1	$\chi2(1) = 0.290$, p = 0.590
	% Disagree	3.6	5.6	
	% Strongly disagree	0.9	0.0	
Attitudes	**How much does it matter what you eat?**	n = 111	n = 18	
	% A lot	38.7	27.8	
	% Some	51.4	61.1	0.5 (95% CI: 0.192 - 1.188)
	% Not very much	9.9	11.1	$\chi2(1) = 2.527$, p = 0.112
	% Not at all	0.0	0.0	
	How much does it matter whether or not you are healthy?	n = 107	n = 17	
	% A lot	59.8	41.2	
	% Some	32.7	52.9	0.6 (95% CI: 0.206 - 1.476)
	% Not very much	6.6	5.9	$\chi2(1) = 1.405$, p = 0.236
	% Not at all	0.9	0.0	

The effect of total cholesterol on knowledge and attitudes were assessed using ordinal logistic regression with proportional odds. *Bold: significant ($p < 0.05$), OR = Odds Ratio. TC = total cholesterol

Table 15 1: Association between total cholesterol and knowledge, attitudes and behaviours (continue)

	Statements	Acceptable TC	Borderline/High TC	Responses in 'at risk' category				OR (Borderline/High TC vs Acceptable TC) 'at risk'
				Acceptable TC		Borderline/ High TC		
				n	%	n	%	
Behaviours	**Fresh fruit**	n = 111	n = 18					
	% > 5 days per week	15.3	22.2					
	% 4 - 5 days per week	23.4	11.1					1.3 (95% CI: 0.442 - 3.620)
	% 2 - 3 days per week	39.6	38.9	68	61.3	12	66.7	χ2(1) = 0.192, p = 0.662
	% 1 day per week	18.9	16.7					
	% Never	2.8	11.1					
	Raw or salad vegetables	n = 111	n = 18					
	% > 5 days per week	21.6	5.6					
	% 4 - 5 days per week	21.6	27.8					1.5 (95% CI: 0.534 - 4.352)
	% 2 - 3 days per week	27.9	33.3	63	56.8	12	66.7	χ2(1) = 0.619, P = 0.431
	% 1 day per week	21.6	16.7					
	% Never	7.3	16.6					
	Cooked green vegetables	n = 111	n = 18					
	% > 5 days per week	19.8	16.7					2.0 (95% CI: 0.632 - 6.646)
	% 4 - 5 days per week	17.1	5.6					χ2(1) = 1.431, p = 0.232
	% 2 - 3 days per week	27.1	44.4	70	63.1	14	77.8	
	% 1 day per week	25.2	16.7					
	% Never	10.8	16.6					
	Doughnuts	n = 111	n = 18					
	% > 5 days per week	9.9	16.7					0.9 (95% CI: 0.350 - 2.565)
	% 4 - 5 days per week	17.1	22.2					χ2(1) = 0.011, p = 0.915
	% 2 - 3 days per week	24.3	11.1	57	51.4	9	50	
	% 1 day per week	32.4	38.9					
	% Never	16.3	11.1					
	Hot chips (Fries)	n = 111	n = 18					
	% > 5 days per week	12.6	5.6					0.9 (95% CI: 0.337 - 2.503)
	% 4 - 5 days per week	11.7	16.7					χ2(1) = 0.027, p = 0.867
	% 2 - 3 days per week	33.3	33.3	64	57.7	10	55.6	
	% 1 day per week	35.1	38.9					
	% Never	7.3	5.5					
	Meat pies/sausage rolls	n = 111	n = 18					
	% > 5 days per week	9.0	5.6					1.7 (95% CI: 0.624 - 4.641)
	% 4 - 5 days per week	7.2	16.7					χ2(1) = 1.080, p = 0.299
	% 2 - 3 days per week	26.1	33.3	47	42.3	10	55.6	
	% 1 day per week	40.5	33.3					
	% Never	17.2	11.1					
	Regular fizzy/soft drinks	n = 110	n = 17					
	% > 5 days per week	15.5	11.8					0.9 (95% CI: 0.309 - 2.879)
	% 4 - 5 days per week	7.3	5.9					χ2(1) = 0.011, p = 0.917
	% 2 - 3 days per week	26.4	29.4	80	72.7	13	76.5	
	% 1 day per week	26.4	17.6					
	% Never	24.4	35.3					
	Breakfast	n = 111	n = 18					
	% > 5 days per week	24.3	44.4					0.4 (95% CI: 0.129 - 1.049)
	% 4 - 5 days per week	18	22.2					χ2(1) = 3.499, p = 0.061
	% 2 - 3 days per week	37.8	27.8	64	57.7	6	33.3	
	% 1 day per week	11.7	0.0					
	% Never	8.2	5.6					
	High-fat takeaway foods	n = 111	n = 17					
	% > 5 days per week	3.6	0.0					0.9 (95% CI: 0.103 - 8.099)
	% 4 - 5 days per week	18.0	11.8					χ2(1) = 0.006, p = 0.936
	% 2 - 3 days per week	73.0	82.4	105	94.6	16	94.1	
	% 1 day per week	5.4	5.8					
	% Never	0.0	0.0					

The effect of total cholesterol on behaviour was assessed using binomial logistic regression with proportional odds. *Bold: significant ($p < 0.05$), OR = Odds Ratio. TC = total cholesterol

Table 15 only highlighted one association between borderline/high TC and health-related KAB. Adolescents with acceptable TC were more likely to have higher awareness on links between exposures to personal nutritional environment and health outcome of the offspring later in life compared to adolescents with borderline/high TC ($p = 0.011$). This shows that adolescents with acceptable TC are aware of the long-term impact of nutrition on the future health outcome of their offspring compared to those with borderline/high TC. There was a trend towards a positive association between borderline/high TC adolescents and not meeting the guideline for breakfast (> 5 days per week). However, this was not significant ($p = 0.061$). There were no other significant associations found between borderline/high TC and health-related KAB. This indicates that apart from the relationship found; poor health-related KAB is unlikely associated with borderline/high TC in adolescents.

Associations between low-density-lipoprotein and knowledge, attitudes and behaviours

Table 15: Association between low-density-lipoprotein and knowledge, attitudes and behaviours

	Statements	Acceptable LDL	Borderline/High LDL	OR (Acceptable LDL vs Borderline/High LDL)
Knowledge	**The food I eat now affect my health in the future**	n = 91	n = 11	
	% Strongly agree	41.8	30.0	0.5 (95% CI: 0.161 - 1.552)
	% Agree	35.2	20.0	$\chi2(1) = 1.440$, p = 0.230
	% I don't know	11.0	10.0	
	% Disagree	8.8	39.0	
	% Strongly disagree	3.2	1.0	
	It is important for me to eat healthy food now	n = 91	n = 10	
	% Strongly agree	85.7	80.0	
	% Agree	13.2	20.0	0.8 (95% CI: 0.160 - 4.195)
	% I don't know	1.1	0.0	$\chi2(1) = 0.058$, p = 0.810
	% Disagree	0.0	0.0	
	% Strongly disagree	0.0	0.0	
	The food I eat now may affect the health of any children I have in the future	n = 92	n = 10	
	% Strongly agree	15.2	10.0	
	% Agree	35.9	30.0	0.5 (95% CI: 0.159 – 1.528)
	% I don’t know	25.0	20.0	$\chi2(1) = 1.502$, p = 0.220
	% Disagree	19.6	40.0	
	% Strongly disagree	4.3	0.0	
	The food a father eats affects the health of his children when it is grown up	n = 92	n = 10	
	% Strongly agree	6.5	10.0	
	% Agree	19.6	30.0	2.2 (95% CI: 0.693 – 6.709)
	% I don’t know	32.6	30.0	$\chi2(1) = 1.761$, p = 0.184
	% Disagree	34.8	30.0	
	% Strongly disagree	6.5	0.0	
	The food a father eats affects the health of his children they are babies	n = 92	n = 10	
	% Strongly agree	13.0	20.0	
	% Agree	21.7	10.0	0.9 (95% CI: 0.282 - 2.672)
	% I don’t know	27.2	30.0	$\chi2(1) = 0.061$, p = 0.805
	% Disagree	31.5	40.0	
	% Strongly disagree	6.5	0.0	
	The food a woman eats when she is pregnant affects the health of her baby when it is grown up	n = 92	n = 10	
	% Strongly agree	31.5	30.0	
	% Agree	26.1	20.0	0.8 (95% CI: 0.287 – 2.698)
	% I don’t know	26.1	30.0	$\chi2(1) = 0.050$, p = 0.822
	% Disagree	13.0	20.0	
	% Strongly disagree	3.3	0.0	
	The food a woman eats when she is pregnant affects the health of her baby when it is grown up	n = 92	n = 10	
	% Strongly agree	54.3	80.0	
	% Agree	26.1	20.0	2.5 (95% CI: 0.614 - 10.310)
	% I don’t know	14.1	0.0	$\chi2(1) = 1.644$, p = 0.200
	% Disagree	4.3	0.0	
	% Strongly disagree	1.1	0.0	
Attitudes	**How much does it matter what you eat?**	n = 92	n = 10	
	% A lot	41.3	40.0	
	% Some	47.8	50.0	0.9 (95% CI: 0.265 - 2.903)
	% Not very much	10.9	10.0	$\chi2(1) = 0.046$, p = 0.829
	% Not at all	0.0	0.0	
	How much does it matter whether or not you are healthy?	n = 92	n = 10	
	% A lot	55.1	60.0	
	% Some	38.2	40.0	1.1 (95% CI: 0.310 - 3.727
	% Not very much	5.6	0.0	$\chi2(1) = 0.013$, p = 0.908
	% Not at all	1.1	0.0	

The effect of low-density-lipoprotein on knowledge and attitudes were assessed using ordinal logistic regression with proportional odds. LDL = low-density-lipoprotein. OR = Odds Ratio.

Table 16 1: Association between low-density-lipoprotein and knowledge, attitudes and behaviours (continue)

	Statements	Acceptable LDL	Borderline/High LDL	Responses in 'at risk' category Acceptable LDL		Borderline/High LDL		OR (Borderline/High LDL vs Acceptable LDL) 'at risk'
				n	%	n	%	
Behaviours	**Fresh fruit**	n = 92	n = 10					
	% > 5 days per week	15.2	20.0					
	% 4 - 5 days per week	20.7	0.0					2.6 (95% CI: 0.522 - 12.564)
	% 2 - 3 days per week	42.4	50.0	59	64.1	8	80	$\chi2(1) = 1.342$, p = 0.247
	% 1 day per week	18.5	10.0					
	% Never	3.2	20.0					
	Raw or salad vegetables	n = 92	n = 10					
	% > 5 days per week	15.2	20.0					
	% 4 - 5 days per week	19.6	30.0					0.7 (95% CI: 0.184 - 2.300)
	% 2 - 3 days per week	32.6	10.0	60	65.2	5	50	$\chi2(1) = 0.445$, p = 0.505
	% 1 day per week	21.7	30.0					
	% Never	10.9	10.0					
	Cooked green vegetables	n = 92	n = 10					
	% > 5 days per week	13.0	20.0					2.0 (95% CI: 0.406 - 9.862)
	% 4 - 5 days per week	17.8	0.0					$\chi2(1) = 0.725$, p = 0.395
	% 2 - 3 days per week	28.1	40.0	64	69.6	8	80	
	% 1 day per week	28.1	10.0					
	% Never	13.0	30.0					
	Doughnuts	n = 92	n = 10					
	% > 5 days per week	8.7	20.0					0.8 (95% CI: 0.222 - 2.736)
	% 4 - 5 days per week	20.7	0.0					$\chi2(1) = 0.150$, p = 0.698
	% 2 - 3 days per week	22.8	20.0	48	52.2	8	80	
	% 1 day per week	30.4	40.0					
	% Never	17.4	20.0					
	Hot chips (Fries)	n = 92	n = 10					
	% > 5 days per week	8.7	20.0					1.3 (95% CI: 0.359 - 4.800)
	% 4 - 5 days per week	10.9	20.0					$\chi2(1) = 0.169$, p = 0.681
	% 2 - 3 days per week	37.0	30.0	52	56.5	7	70	
	% 1 day per week	39.1	20.0					
	% Never	4.3	10.0					
	Meat pies/sausage rolls	n = 92	n = 10					
	% > 5 days per week	5.4	20.0					1.5 (95% CI: 0.435 - 5.377)
	% 4 - 5 days per week	9.8	10.0					$\chi2(1) = 0.440$, p = 0.507
	% 2 - 3 days per week	28.3	30.0	40	43.5	6	60	
	% 1 day per week	39.1	30.0					
	% Never	17.4	10.0					
	Regular fizzy/soft drinks	n = 91	n = 10					
	% > 5 days per week	14.3	40.0					1.0 (95% CI: 0.238 - 3.959)
	% 4 - 5 days per week	18.7	10.0					$\chi2(1) = 0.002$, p = 0.966
	% 2 - 3 days per week	40.7	20.0	67	73.6	7	70	
	% 1 day per week	23.1	20.0					
	% Never	3.2	10.0					
	Breakfast	n = 92	n = 10					
	% > 5 days per week	27.2	30.0					1.7 (95% CI: 0.469 - 6.253)
	% 4 - 5 days per week	21.7	10.0					$\chi2(1) = 0.662$, p = 0.416
	% 2 - 3 days per week	31.5	30.0	47	51.1	6	60	
	% 1 day per week	12.0	0.0					
	% Never	7.6	30.0					
	High-fat takeaway foods	n = 91	n 10					
	% > 5 days per week	3.3	10.0					2.3 (95% CI: 0.457 - 11.073)
	% 4 - 5 days per week	16.5	10.0					$\chi2(1) = 0.995$, p = 0.319
	% 2 - 3 days per week	75.8	80.0	87	95.6	10	100	
	% 1 day per week	4.4	0.0					
	% Never	0.0	0.0					

The effect of low-density-lipoprotein on behaviour was assessed using binomial logistic regression with proportional odds. LDL = low-density-lipoprotein. OR = Odds Ratio.

Table 16 presents the association between LDL and health-related KAB. Although there were many health-related KAB variables examined in relation to LDL, the results yielded no associations. This indicates that inadequate levels of health-related KAB are not linked to borderline/high LDL in adolescents.

Conclusion

Overall, this study highlighted a significant proportion of adolescents are overweight/obese, centrally obese and at high risk of prehypertension/hypertension. Boys were more likely to be at higher risk of prehypertension/hypertension compared to girls, However; girls were more likely to have elevated total cholesterol compared to boys. This indicates that a high proportion of the study sample has risk factors known to link to NCDs in adulthood, such as hypertension and obesity.

Although this study sample shows a reasonable level of knowledge and attitude around nutrition and life-course impact of nutrition, however, it presents with alarming dietary behaviours with some gender-related differences. Most were not meeting the guideline for fruit and vegetable intake per week. Boys were not likely to not meet the guideline for fruit intake compared to girls. On the other hand, a high proportion of adolescents are eating foods high in fat, skipping breakfast and eating take outs more than the recommended intake per week. Boys were more likely to eat doughnuts, and meat pies/sausage rolls nearly every day in an average week compared to girls. Girls were more likely to miss having breakfast less than five days per week compared to the boys. These poor dietary patterns are known major risk factors for NCD later in life.

In addition to the different associations found, there were also many other relationships that did not show any differences between groups. WHtR and LDL were found not to be related to inadequate levels of health-related KABs. One of the reasons for why there is no association found between WHtR and health-related KAB could be related to the fact that it is most effective when combined with BMI as outlined in the Method Chapter. There were also some factors in health-related KABs that were not linked to BMI, BP and TC. BP showed the most associations while TC had only one relationship found. Even though there were some trends showing positive associations, however, they were not noteworthy. This chapter has exclusively described the results and relationships found within this study cohort. The next chapter discusses these results further.

CHAPTER FIVE: DISCUSSION, RECOMMENDATIONS & CONCLUSION

"Potipoti enua ko Atiu
E vaine te mea akaroa
E tamariki te mea akaroa
Taku patu paepae te mea akaroa kavaio
Ie-e-ko-kko"
The land of my ancestors – Atiu
Her maidens will live long
Her children will live long
The sacred place of my ancestor will be there forever

- **Mariri Tu Tu A Manu**

This chapter discusses the overall main findings in relation to common themes identified in the literature. Part one explores the results of this study within the context of the primary research aim: to examine the associations between anthropometric and health-related knowledge, attitudes and behaviours (KAB) among Rarotongan Year 9 students prior to participating in the Pacific Science for Health Literacy Project (PSHLP) in 2016. Part two examines the strengths and limitations of this study. Part three recommends future actions to improve gap in the literature and addressing adolescent health in Rarotonga. The fourth part summarises key areas in this thesis and concludes the overall research.

Part one: Interpretation of findings

Objective one: To examine factors contributing to non-communicable disease risk factors among Year 9 Rarotongan high school students

Development of non-communicable risk factors

This study found high prevalence rates of non-communicable (NCD) risk factors present among this study cohort. A proportion of 64.4% are overweight/obese, 58.1% at risk of raised blood pressure (BP), and 32.6% were centrally obese. Boys were more likely to be at higher risk of increased BP compared to girls ($p = 0.009$). However, girls were more likely to have elevated total cholesterol (TC) compared to boys ($p = 0.009$). This evidence is concerning because the risk factor is occurring among a young cohort age between 12 to 14 years, which is only from a small subsection of the total Rarotongan and overall Cook Islands youth population. Research shows when risk factors develop at an early age; they are likely to continue over time, maintaining a high-risk status (Al-Hazza et al., 2012). This pattern has been linked to adverse health outcomes, including cardiovascular diseases, during adulthood. For instance, a longitudinal study showed that high BP in an adolescent is associated with a number of cardiovascular risk factors such as hypertension and diabetes in adulthood (McCarron, Smith, Okasha, & McEwen, 2000). Thus, because the development of NCD has its origin in childhood, approaches to prevention must be directed at the developing adolescent.

Furthermore, risk factors initiating in early adolescence have been linked to early onset of NCD in adulthood (Goran, Ball, & Cruz, 2003; Hannon, Rao, & Arslanian, 2005; Lurbe, Alvarez, & Redon, 2001). For instance, McQuaid et al. (2005) found that obesity in adolescence is associated with a much earlier presentation of type 2 diabetes in mid-adulthood age between 25 to 45 years, leading to high morbidity rates. As a result, this can negatively affect the most economically productive working group in a society. For example, individuals diagnosed with diabetes have increased sick days or forced into early retirement. The Cook Islands is a developing country, whose productivity and growth mainly depends on the working age group. The impact of early onset of NCD will challenge its economic growth which can limit its capacity to respond to the growing epidemic of NCD. Therefore, by reducing exposure to risk factors early in life, can prevent future losses in employment and work productivity, at the same time enhance economic growth. Hence, prevention of NCD in

adolescence yields economic benefits in addition to improving health status and quality of life.

Subsequently, risk factors starting in adolescence has been associated with increased likelihood of premature deaths (before 70 years) (Engeland et al., 2003; Franks et al., 2010; Neovius, Sundstrom, & Rasmussen, 2009; Reilly & Kelly, 2011; Van Dam, Willett, Manson, & Hu, 2006). For instance, Frank et al. (2010) found among 4,857 adolescents age 11 – 12 years in the USA, children in the highest quartile of BMI were more than double the risk of premature death than those in the lowest BMI quartile. This present study found a high rate of the participants were obese/overweight, centrally obese and at-risk of high BP. This prevalence is similar to that observed in the literature associated with increased likelihood of early death. Thus, findings from this study reflect the future burden of premature death if this is not corrected. Failing to reverse the trend may have wide-reaching consequences for the quality of life and longevity in the Cook Islands. Such evidence underlies the importance of preventing risk factors starting in adolescence.

In addition to the future health risks, adolescents also suffer short-term health consequences. These include breathing difficulties, increased risk of fractures, hypertension, early markers of cardiovascular disease, insulin resistance and psychological effects (World Health Organization, 2015c). In turn, these can affect the student's ability to participate in school and continue with other daily activities (Piryani, Baral, Pradhan, Poudyal, & Piryani, 2016). A research study found that overweight and obese children were four times more likely to report having problems at school than their normal-weight peers (Schwimmer, Burwinkle, & Varni, 2003). This study cohort is based on Year 9 students who are just beginning secondary with high rates of NCD risk factors. This is worrying because of the short-term effects as this can negatively impact the rest of their education years and may lead to completion of fewer years of school. It is therefore essential to address this age group to prevent early dropouts and regular absentees in school.

Objective two: To identify and explore the knowledge, attitudes and behaviour profile of Year 9 Rarotongan high school students

Level of nutritional knowledge

This study found that participants show more awareness on the importance of eating healthy food now compared to links between nutrition and health. This lack of awareness might be unsafe because these are the individuals who are entering society with a high NCD epidemic and should be knowledgeable about the impacts of nutrition on health and their prevention. Since the cohort in this study was considerably less attentive about the impacts of nutrition on health, efforts should be concentrated on awareness-raising programs among this age group.

Moreover, the participants show more awareness of links between the impacts of personal and maternal nutrition on the health outcome of the offspring later in life compared to the impacts of paternal nutrition. Literature has found that the father's diet before conception is just as crucial to a child's health (Gluckman & Hanson, 2006). Therefore, nutrition education programs promoting child health need to target both future mums and dads. This is important for protecting the health and well-being future generations in the Cook Islands.

Level of attitudes towards health and wellbeing

Most of the participants in this study place more value on being healthy compared to what they eat. Attitude has been associated to influence dietary habits (Schrader & Lawless, 2007). As a result, the implication of poor attitude towards nutrition means adolescents would adopt unhealthy eating behaviours. For instance, when an individual is convinced that eating healthy does not matter, therefore more likely to engage in unhealthy eating. On the other hand, there is a body of literature that suggests that having positive attitudes does not necessarily mean the individual will practice healthy eating (Shepherd et al, 2005). There are other contributing factors beyond having positive attitudes that can, in turn, affect their eating habits, for instance, lack of access to healthy food. This highlights that attitudes alone may not be a sufficient factor for influencing change in healthy eating behaviours. But coupled with other interventions such as addressing the environment, for instance, availability of cheaper healthy foods in school canteens, may help support the participant's attitudes further in the context of the Cook Islands.

Development of unhealthy nutrition habits leading to NCD development

This study found striking evidence of poor self-reported food consumption and meal patterns and they discussed further in the following subsections.

Fruit and vegetable

This study showed that the average weekly fruit and vegetable consumption among the study participant is lower than the recommended intake per week. Only 38.3% met the WHO guideline for fruit intake, 41.4% met the guidelines for raw or salad vegetable intake, and 34.6% met the guidelines for cooked green vegetable intake. Boys were 2.6 times more likely to not meet the fruit intake compared to girls ($p = 0.008$). Studies indicate that adequate nutrition is especially important during adolescence, which is a period of biological and social change (Lazzeri et al, 2014). These are crucial years for healthy physical and mental development, and the diet and eating behaviours that develop during these years tend to persist throughout life. If habits acquired in adolescence persist into adult life, behaviours established in young people may have significant long-term consequences for health. The Cook Islands have a high NCD morbidity and premature rates and reduction in these areas may be achieved if satisfactory nutritional practices are adopted in early life and remained in the long-term. Although this may be challenging, given there are factors at large that may influence their behaviour over the life-course, but it is achievable. By educating students to use appropriate evidence in decision making regarding NCD risk reduction in the context of Rarotonga.

High-fat foods

At baseline, this study found overconsumption of energy-dense, nutrient-poor, high-fat foods among the study participants. Over half of the participants are eating hot chips (56.1%) and doughnuts (51.9%) more than one day a week. Boys were two times more likely to eat doughnuts ($p = 0.045$) and 2.3 times more likely to meat pies/sausage rolls ($p = 0.022$) on a daily basis compared to girls. These foods are known significant risk factors for elevated blood pressure, blood cholesterol, BMI and cardiovascular diseases later in life (Niinikoski & Ruottinen, 2012). For instance, Hatamai et al. (2014) conducted a cross-sectional study among 1,157 children age between 10 to 18 years old in Iran to investigate the relationship between high-fat diets and BMI. The study found that overweight/obesity in children is significantly associated with a higher intake of energy-dense foods ($p < 0.001$). The high

intake of energy-dense foods might help explain the high prevalence of NCD risk factors present in this study cohort. However, noting that there could be other at-risk foods that might have caused poor health among the study participants. At the same time, it also highlights the importance of addressing short and long-term health impact of consuming foods high in fat among adolescents.

Regular fizzy or soft drink

At baseline, this study found that 71.8% were drinking fizzy or soft drinks on a daily basis. The World Health Organization (WHO) recommends that children consume less than one day per week. This study found that the participants are consuming more than one day per week. There is substantial evidence indicating that consuming beverages high in sugar more than once a week over an extended period of time is associated with an increased risk of obesity and NCD risks in adolescents (Perichart-Perera et al., 2010). This highlights the need to develop policies and programs designed to limit the consumption of fizzy or soft drinks among adolescents, including other means such as taxation, public awareness campaigns and reduce availability in school and other settings in Rarotonga.

High-fat takeaway foods

A high frequency of the study participants (82.7%) is eating high-fat takeaway foods more than the recommended WHO guideline of less than one day per week. Cohort studies have shown that high consumption of high-fat takeaway foods in adolescence is associated with higher BMI later in adult life (Ambrosini et al., 2010; Garcia-Continente et al., 2015). If this is the case, even with lower BMIs found among the participants, with more frequent consumption of high-fat takeaway foods can lead to adverse health outcomes later in life.

Breakfast

Overall, 80.3% of the participants reported skipping breakfast less than five days per week. Boys were 2.4 times more likely to miss breakfast (< 5 days per week) compared to girls ($p = 0.008$). Eating breakfast every day is a good indicator of proper nutritional intake and healthy eating behaviours (Clinical Trials Research Unit, 2010). Children who do not eat breakfast are more likely to eat foods high in fat and/or sugar and more likely to be overweight or obese (Utter, Scragg, Ni Mhurchu, & Schaaf, 2007). Interestingly, this study noted that boys are more likely to eat doughnuts and meat pies/sausage rolls more than one day per week. This indicates as a result of them missing having breakfast at home, boys are likely to turn to

eating foods high in fat, which are potential markers for obesity. Breakfast consumption is the ‘most important meal of the day’, it provides nutritional and health-related benefits compared to other meals. Thus, intervention to improve dietary patterns among the study participants should focus on the breakfast meal.

Objective three: To examine the associations between factors contributing to NCD risks and health-related knowledge, attitudes and behaviours of Year 9 Rarotongan high school students

The relation of BMI and attitudes towards nutrition and sugar-sweetened beverage consumption

This study found that overweight students are more convinced that the food they eat matters 'a lot' compared to those who are healthy (OR = 2.6, p = 0.026). There was a trend towards positive associations between obese/severely obese students and attitudes towards nutrition. However this was not found to be statistically significant (OR = 2.0, p = 0.091). This highlights that overweight students are aware of the health benefits of nutrition. Despite this attitude, it does not seem to influence the participants BMI. This suggests that there could other contributing factors beyond having a positive attitude that might have potentially encouraged the high BMI of overweight adolescents. The finding from this study is consistent with another study conducted by Gordon-Larson (2001). Gordon-Larson (2001) found that despite having positive attitudes, there were environmental factors that played a far more prominent role in influencing BMI. This highlights the importance of modifying the school environment at the policy level as this can impact the health of both the participants and other students at large.

Obese/severely obese students were 2.7 times more likely to consume fizzy drinks nearly every day compared to those who are healthy (p = 0.058). Obesity/overweight is very high among this study cohort. Although causes of obesity are multifactorial, but the baseline evidence from this study suggests that fizzy or soft drinks are a significant contributing factor. This finding is consistent with a Pacific multi-national cross-sectional study conducted among 10,424 children age between 13 to 16 years old (Pengpid & Peltzer, 2015). The study found that overweight was associated with higher intake of carbonated drinks (one or more drinks per day) (p < 0.01). For these reasons and because soft drinks have little nutritional value, it should be limited and replaced by healthier alternatives such as water among the participants.

The relation of blood pressure and knowledge on healthy eating, links between personal, maternal nutritional environment and health outcome of offspring and fruit consumption

At baseline, this study found that adolescents with normal BP are more likely to have a higher level of awareness on the impact of personal nutrition on the health outcome of the

offspring later in life compared to those with raised BP (OR = 0.5, p = 0.037). This type of knowledge is highly essential for participants with raised BP to be aware of as they are more at risk of passing the disease trait to the next generation. There are significant body of literature which highlighted that risk factors initiating in adolescence track through to adulthood, therefore increasing the chance of passing on the risks to the offspring during pregnancy (Gluckman & Hanson, 2006). Participants with raised BP need to be aware of this implication as it does not only negatively affect their short and long-term health, but also of their offspring.

Moreover, this study also found that adolescents with normal BP are more likely to have a higher level of awareness of links between impacts of maternal nutrition on the long-term health outcome of the offspring (OR = 0.5, p = 0.017). This knowledge is much more important for girls with high BP to be aware of as literature highlighted that maternal nutrition is one of the contributors for reduced long-term health outcome among their offspring. For instance, mothers who eat a high-fat diet during gestation and through lactation, produces offspring with increased measures of adiposity after weaning, including higher body weight, perineal adipose tissue, and adipocyte hypertrophy (Bayol, Farrington, & Stickland, 2007). Thus, at-risk girls, need to be aware of this association prior to becoming a mum.

This study found that students with raised BP are 4.6 times more likely to strongly-agree/agree that it is essential for them to eat healthy food now compared to those of healthy BP (p = 0.020). This suggests that these individuals are aware of the benefits of consuming adequate nutrition now. However, this association does not remain when asked of their understanding of the long-term health benefits of eating healthy food now. Moreover, even though it is beneficial having this knowledge, it does not seem to influence the participants BP. This highlights there could be other factors contributing to the high BP among the participants. This finding is similar to another study conducted by Khalesi et al. (2016). Khalesi et al. (2016) conducted a cross-sectional study among individuals aged 18 years old among 322 Australians. Khalesi and colleagues identified that high BP is not associated with nutritional knowledge. The authors go on and state that the participants high BP could be influenced by many factors including socioeconomic and cultural conditions. This could help explain why the participants in this study have high BP.

Furthermore, this study found that students with raised BP are 2.6 times less likely to eat fresh fruit (p = 0.010). The findings from this study correlate with a meta-analysis undertaken by Bingrong et al. (2016). The authors found a pooled relative risk of hypertension for the highest vs the lowest consumption of fruit of 0.73 (p = 0.002). The authors concluded that high fruit consumption reduces risks of hypertension, whereas low consumption heightens this risk. This highlights the need to raise the awareness of health impacts of low fruit consumption among this study cohorts.

The relation between total cholesterol and impact of personal nutritional environment on the health outcome of the offspring

This study found that participants with acceptable TC levels had more awareness of the impact of exposures to personal nutritional environment on the future health outcome of the offspring (OR = 0.3, p = 0.011) compared to those with borderline/high TC. Although adolescents with acceptable TC levels show more awareness on the long term impact of nutrition on their offspring, however it does not reflect in their dietary patterns. This shows despite having higher knowledge, both groups are still at risk because of their poor habits. Therefore, both groups need to be targeted in the raising awareness program through transformative educational program to move the students from knowing facts to translating it into practice. These are crucial for influencing their future health outcome and also of that of their future offspring.

No association between some anthropometric and health/lifestyle related knowledge, attitudes and behaviour

While this study found relationships between adolescent health and health-related KAB, there were many relationships that were not showing any associations. These findings are consistent with the results from a collection of studies detailed in the literature review (Chapter 2). Seven studies found no associations' between adolescent health and KAB (Azizi-Soleiman et al., 2016; Gordon-Larson, 2001; Laurson et al., 2007; McNaughton et al., 2008; Reinehr, Mathilde, Christa, Anke, & Werner, 2001; Schert-Hellert et al., 2011; Villers et al., 2016). Critical themes identified from these studies on the reasons why there were no associations found are further discussed below.

Early life environment

According to the literature, one of the potential reasons why the participants in this study have poor health indicators points towards their early-life factors as theorised by DOHaD. Evidence from DOHaD studies suggests that there is a relationship between birth weight and the onset of obesity, raised blood pressure, and disturbed cholesterol metabolism in adolescence (Barker et al., 2001). For instance, Martorell & Schroeder (2001) found a linear relationship between BMI in adolescence and birthweight. Mortorell & Schroeder highlighted that the risk of obesity is higher among those babies born with low birth weight. However, it is important to make a point here that it would be a misconception to think that lower birthweight, in itself, causes later disease. But instead, that the birthweight occurs because of the programming that took place while the offspring was still in the womb. An example of the consequences of the programming includes poor maternal diet and the transfer of nutrient from mother to fetus. This data was not captured in this study. Nevertheless, supporting evidence from international studies suggests that poor health among adolescents points back to what the mother ate during and before pregnancy. It is clear, the presence of NCD risks among this study participants could point back to what their mothers ate during conception and preconception.

Other scientific evidence from DOHaD studies suggests that maternal health does play a role in passing on the risks to their offspring. For example, maternal diabetes during pregnancy exposes the fetus to excess nutrients. The result of this action gives rise to a newborn who is significantly larger than average (more than 8 pounds) (Dabelea, Hanson, & Lindsay, 2000). This evidence highlights that there are problems at both ends of the birth weight spectrum and that both low and large birthweight are indicators for later risks of NCD. This suggests that interaction that took place before and during pregnancy affects the birthweight in turn impacts later risk of NCD. Hence, this proves that maternal health may have resulted in the presence of high NCD risks found among the participants in this study.

While much of the discussion in literature has been on the interactions between mother-offspring, another body of literature identified that paternal factors too, play a role in influencing the future health outcome of the offspring. Research evidence shows that paternal diet can have transgenerational consequences. Kaati et al. (2002) assert that high amounts of poor diet during the father's pre-adolescence correlated with a lower chance of cardiovascular mortality in offspring. The authors further found that the effect was held true when the

grandfather of that same offspring was subject to low, poor diet during pre-adolescent's period. These correlations suggest that there are factors that are passed down paternally over multiple generations via epigenetics. Although this data was not captured in this study, the evidence presented helps shed light, that in addition to maternal nutrition, the participants poor health could be attributed by their fathers and grandfathers lack of adequate nutrition.

In addition, the fathers health also play a significant role in passing on the risks to their offspring. Soubry et al. (2013) determined that paternal obesity is linked with hypomethylation at the methylated regions of the IGF2 gene. When this action takes place, there is increased circulation of IGF2 proteins, which are associated with increased likelihood of obesity. Soubry and colleagues furthers shows that, apart from paternal nutrition, paternal health prior to mating can negatively impact the health of the future generations. Thus, the participants' poor health could be linked to their father's health during the preconception and conception period.

Moreover, there is increasing evidence that both parents hold a significant part in transmitting the disease to their offspring. Frisancho (2000) found that parental obesity may be even more important than massive birth weight in predicting the risk of obesity in adolescence. There are cases where only one parent has a health problem as previously described. But in this case, both parents have health problems, and the predicted impact of risks is more significant compared to coming from one of the parents. Therefore, based on these key findings, a contributing factor for the high overweight/obesity in this study could be linked to the health of their parents.

There are many early-life factors that contribute to the poor health outcome of the offspring later in life. These include maternal health and nutrition, paternal health and nutrition, parental health and nutrition. Of more concerning is that the risks are passed onto the next generation, a process called early-life programming (Figure 7). As a result, this can cause an inter-generational transmission of disease risk. For instance, if maternal under-nutrition and poor fetal development recur across generations, the children are at risk of developing adult cardiometabolic diseases, especially if they become overweight or obese postnatally (Fall, 2013). If the child is female, she is at later risk of becoming diabetic in pregnancy (gestational diabetes), leading to fuel-mediated teratogenesis and exposing the fetus to another route to later cardio-metabolic risk (Huda, Brodie, & Sattar, 2010). The inter-generational nature of NCD disease risk can delay the Cook Islands from reaching their goal

of reducing the prevalence rates by 2% per year (Cook Islands Ministry of Health, 2015). In spite of this, the central message in DOHaD is that risks are passed on through before and during pregnancy. This highlights the importance of addressing health and wellbeing prior to the reproductive years, and this is during the adolescent period, as this will not only promote the health of the individual but also their children as well.

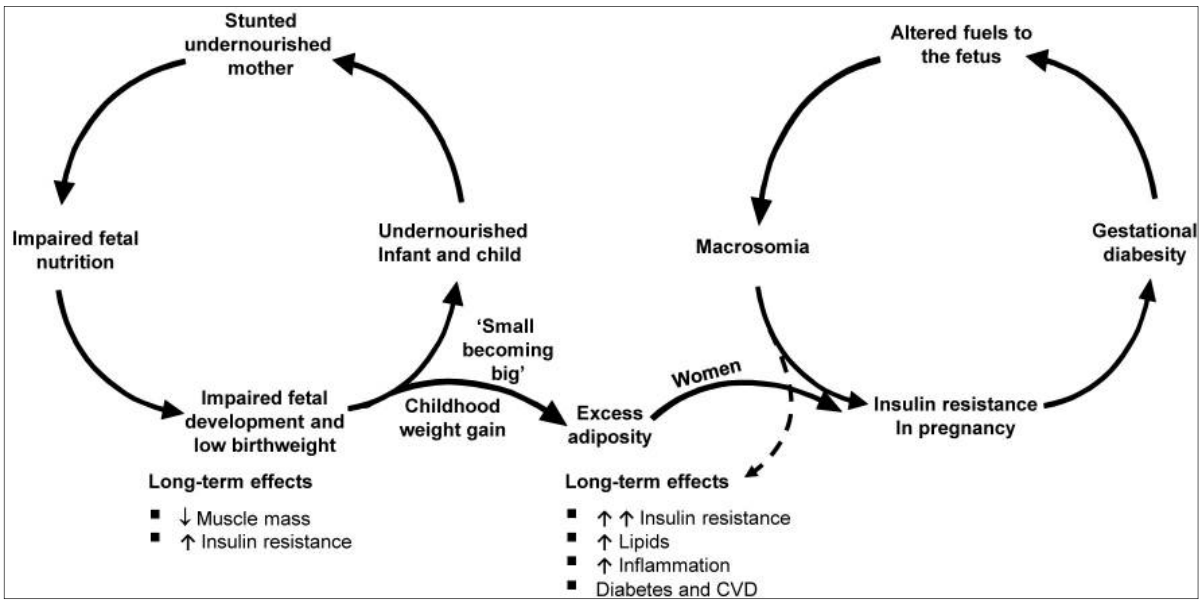


Figure 7: Inter-generational pathways of fetal programming (Fall, 2013)

Even though, much of the evidence supporting early-life factors are mainly conducted from high-income and developed countries with different contexts. Despite this, it helps shed lights that there are other causes of NCD risks that need to be further explored within the context of the Cook Islands. This study also implies that there should be no misconception whereby parents are to be blamed for health outcome and well-being of the offspring. But creating awareness that the causes of NCD are multifaceted in nature, as there are also other factors not discussed in this study that are impacting the health and well-being of the participants.

Socioeconomic Determinants of health among adolescents

The term social determinants of health (SDH) refers to:

> *"The conditions in which people are born, grow, live, work and age as well as the systems and the wider set of forces shaping the conditions of daily life and these conditions are shaped by the distribution of money, power, and resources at global, national and local levels and affected by policy choices at each of these levels"*

Dahlgren and Whitehead demonstrate these health determinants clearly as outlined below.

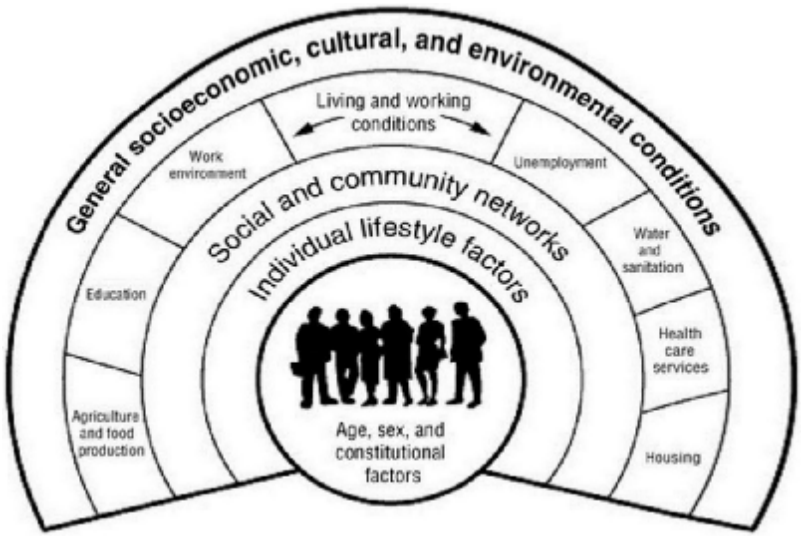


Figure 8: Dahlgren and Whitehead Schema of the main determinants of health (Curie et al., 2012)

At the heart of the model are factors that cannot be changed such as age and sex. Surrounding these are factors that can be changed. The model displays the various level of influences on health outcomes with the individual at the centre and then moving out to the general, socio-economic, cultural and environmental conditions. These layers are:

1) The individual factors: these include the person's age, sex and hereditary factors, for example, male or female
2) The individual lifestyle factors: these include a person's diet, physical activities, smoking and alcohol drinking behaviours
3) Social and community networks: these include the influences of neighbourhoods, families, churches, unemployment, schools, social and cultural
4) Living and working conditions: this includes access to health services, education attainment and unemployment

5) General socioeconomic, cultural and environmental factors: examples of these includes housing, working conditions and access to services

The SDH model help's elucidate that causes of poor health among adolescents are vastly complex. They are caused by more than one factors at the different level of influences and are integrated and overlapping with each other. These factors are shaped by the level of income, power and resources at global, national and local levels. They are not only influenced by personal choices but through policy choices as well. These policies are the drivers of health and health inequalities among adolescents.

It is clear, adolescents grow into adults, within a complex web of four layers of determinants of health that affects their present and future health and wellbeing (Sawyer et al., 2012). The adolescent is a crucial period for the adoption of health-related KAB. These KABs are shaped by the social, economic and cultural forces, and these are significant determinants of health in turn affecting their health outcomes (Due, Damsgaard, & Rasmussen, 2009). There is substantial evidence showing that adolescents living in lower socioeconomic positions are more likely to engage in unhealthy behaviours (Currie et al., 2012; Lazzeri, AzzolinI, & Giacchi, 2014; Murphy et al., 2013). For example, Wang (2001) conducted a cross-national comparison study to investigate the relationship between obesity and socioeconomic status among children age 10 to 18 years. According to this study, low socioeconomic status groups from the United States were more likely to be at higher risk of obesity than higher socioeconomic status groups (Wang, 2001). You & Choo (2016) conducted a cross-sectional study among 63,100 students in South Korea age between 14 to 15 years. The study found that adolescents from low, poor socioeconomic areas are associated with overweight/obesity and low consumption of fruit and vegetables ($p < 0.046$). There is, therefore, a clear a link between the social and economic environments of adolescents and poor health outcomes.

This study did not capture data on socioeconomic positions of the participants. Despite this gap, but evidence from literature helps develop an understanding that the social and economic context of the individual may have played a significant part in influencing poor health outcome among the study participants. Therefore this shows that the impact of NCD goes beyond health and thus the actions towards prevention needs to be multisectoral and multifactorial. However, bearing in mind that the studies supporting this evidence were conducted in developed and high-income countries. The physical, social and economic determinants of these countries may not be the same as the context of the Cook Islands, in

particular, Rarotonga where the participants are based at. There could be other factors not captured in the SDH model affecting the health of the Rarotongan adolescents. This highlights the need for an ethnic-specific SDH model when addressing the health and wellbeing of adolescents in the context of Rarotonga.

Part two: Strengths and limitations

This study also has strengths and limitations. Some of these are as follows:

Strength

There was no existing literature examining associations between adolescent health and health-related knowledge, attitudes and behaviours among Rarotonga adolescents aged 10 to 14 years in the Cook Islands context. Most of the studies previously reported in this area were conducted primarily in developed countries with larger population sizes. Moreover, most of the studies assessed the influences of KAB on health on its own and not together. For example, nutritional behaviour was assessed on its own with impacts on health. Assessing behaviour is not sufficient enough to capture the capabilities used in decision making regarding NCD risk reductions. In saying this, behaviour can be influenced by knowledge or attitudes. Therefore an essential contribution of this study is towards the limited pool of knowledge around the mechanism of NCD risks via KAB influences, in the context of Rarotonga.

The study was conducted by an insider researcher, who is a Cook Islander. The researcher was born and raised in the Cook Islands, who helped interpret the data. Being an insider-researcher was an advantage to this study - was able to speak the same insider language and understand the local values, knowledge, traditional practices and beliefs.

Limitations

This study had a small sample size and was therefore relatively underpowered when compared to other studies in the literature and reflects a limitation when working in a small island setting. A majority of the previously reported studies had more than 500 participants. Only two studies had less than 150 participants, and an essential theme of the limitations identified in these two studies was that the sample size was small. Small sample size has been critiqued for lowering statistical power, inflating false discovery rate and limits generalisation to other settings with larger populations (Button et al., 2013). Although the sample size in this study is small, they represent a significant proportion of the total youth population in the Cook Islands who are the future leaders and parents. Therefore, it is worth investigating their health and wellbeing in the context of primary NCD risk reduction in the Cook Islands.

In accordance with the literature review, the present study employed a cross-sectional study design to examine the links between adolescent health and health-related knowledge,

attitudes and behaviours. However, this study design has limitations whereby it does not directly identify whether adolescent health is caused by health-related knowledge, attitudes and behaviours. But for the purpose of the study design given that it is baseline research examining evidence of Year 9 cohorts prior to taking part in the PSHLP programme, this makes cross-sectional approach fitting. This evidence supports the PSHLP programme in assessing its potential on physical impact of the adolescents.

A fundamental limitation was that the BP of the participants were only measured once. The proper protocol is to take three readings and take the best measure from thereon. However, this was not done. Although this happened, a way to improve the measure was to combine the prehypertension and hypertension values of the participants and coded it as 'raised'. Interestingly this was one of the health indicators that showed more relationships with health-related KAB. This may have happen as the data could be underreported given that it was only measured once, thus may have reduced the reliability of the result.

Part three: Recommendations

The following recommendations derived from the main findings of this study. These recommendations have been made to improve knowledge around mechanisms that influence NCD development and to direct resources on NCD prevention in the Cook Islands.

Policy and practice

This study identified that obese/severely obese more likely to consume fizzy drinks nearly every day and that students with high blood pressure (BP) are less likely to consume fruit and vegetable. These food groups should be prioritised when planning and implementing school health promotion, policy and education programs to improve nutritional status and decrease cardiovascular disease risk later in life among Rarotongan adolescents.

This study found that adolescents with raised BP have imperfect knowledge about links between personal and maternal nutritional environment on the health outcome of the offspring. Similar observation was also noted for participants with borderline/high TC where they show less knowledge around the impact of personal nutritional environment on the health outcome of the offspring. This finding is significant as literature has identified a link between personal and maternal nutritional environment to future health risks of the offspring. This highlights the need to develop school-based health programs that educate adolescents on

the effect of health and lifestyle behaviours on influencing the future health of their offspring, in particular for those at risk.

Factors affecting the health of Cook Islands adolescents are multidimensional. Dahlgren and Whitehead highlighted that the health of adolescents is caused by more than one factor that is found in their social and economic environment. Even though the individual have choices whether to eat unhealthy food or not. But the literature has highlighted that children in particular are increasingly becoming important target markets for the food industry. Food marketers are interested in adolescents as consumers because of their spending power, their purchasing influence and as future adult consumers. Multiple techniques are used to reach adolescents, to influence food product purchase behaviour. The foods marketed towards adolescents are predominantly high in sugar and fat (Story & French, 2004). Moreover, evidences from DOHaD studies found that poor health among adolescents originates from the interactions that took place prior to conception between their parents and have been passed down through generations. Therefore a key recommendation would be to use a multi-faceted approach to address NCD risks in the Cook Islands. These approaches should be invested in adolescents, in addition to adults, as it is strongly supported by the literature that it is one of the most cost-effective approach for NCD risk reduction.

Future research

This study mainly examined the nutritional influences on health outcome, and it did not investigate the impact of physical activity. There is a need to incorporate a physical activity objective in future research when assessing current levels and effectiveness of an intervention.

Most literature around the early-life environment and social determinants of health have been undertaken in developed and western countries. There is a need to investigate the impact of social and economic environments on the health of adolescents in the context of the Cook Islands. Although a previous DOHaD-related study has been conducted in the Cook Islands; this study only examined the links between birth factors and health in adolescence. There is, therefore, a need to investigate whether health-related KAB established in adolescence does influence health outcome later in life.

Another recommendation is to conduct a mixed-method approach in future research. There were areas that required further investigations through interviews. For example, adolescents

with high BP indicated that nutrition is essential, however, it did not alter their dietary patterns thereby influencing their BP. An interview with high-risk individuals would have provided answers on what's affecting their poor health. Data triangulation would have been more beneficial as it would have validated the data through cross verification with other sources from several research methods. In details, it would triangulate quantitative with qualitative and the quantitative analysis that incorporates the findings from the previous two methods. By combining these methods, it help the researcher identify trends and inconsistencies through quantitative research, then use qualitative methods to dig into those issues and find out why they occur. Despite this shortcomings, the use of the quantitative approach enabled the associations between adolescent health and health-related KABs to be identified.

This study only examined a Year 9 cohort on Rarotonga; there is a need to include Year 9 from the outer islands, which will help differentiate health outcomes between the capital and the outer islands. Moreover, it also needs to include Year 9's from other private schools in Rarotonga. This will help give an overall profile of NCD risks among adolescents in the Cook Islands.

Part Four: Conclusion

This study aimed to examine the associations between adolescent health and health-related KAB among Rarotongan Year 9 students prior to participating in the PHSLP programme in 2016. This aim has been met through achieving the following objectives as detailed below.

The first objective was to explore the presence of NCD risk factors among Rarotongan adolescents. This was achieved using anthropometric data. The profile showed that a high number of Rarotongan adolescents were obese/overweight and exhibited signs related to prehypertension/hypertension and raised total cholesterol prior to participating in the PHSLP programme in 2016.

The second objective was to examine the health-related knowledge, attitudes and behaviour among Rarotongan adolescents. This has been achieved by using the KAB profile. The profile highlighted that, while most of the students have a reasonably good level of knowledge and attitudes towards nutrition, a high rate of these students exhibit unhealthy eating and meal patterns prior to taking part in the PHSLP programme in 2016.

The third objective of this study was to examine associations between NCD risk factors and health/lifestyle related KAB. Results from this study show that overweight students are more convinced that the food they eat matters 'a lot' compared to those who are healthy (OR = 2.6, p = 0.026). In addition, obese/severely obese adolescents are 2.7 times more likely to consume fizzy or soft drinks on a daily basis compared to their healthy counterparts. This study also found that students with raised BP are 4.6 times more likely to strongly agree/agree that it is crucial for them to eat healthy food now (p = 0.020). This indicates that students with raised BP have a higher awareness of healthy eating. Moreover, students with BP are 2.6 times less likely to meet the WHO recommended intake of fruit compared to those with normal BP (p = 0.010). However, on the other hand, students with normal BP are more likely to be aware of the impact of personal (p = 0.037) and maternal (p = 0.017) nutrition on the life-long health of their offspring. In addition, students with acceptable TC are more likely to be aware of the impact of personal nutrition on the life-long health of their offspring (p = 0.011). While there were relationships found, there were many other relationships that did not show any associations prior to taking part in the PHSLP programme in 2016. Findings from DOHaD studies highlighted that the participants' poor health indicators could have been influenced by their early-life factors. On the other hand, the Determinants of Health model also suggests that the poor health of adolescents are widely influenced by the social and economic structure that the individual lives in. While this evidence offers potential answers, these are mainly based on developed countries. This highlights the need for further research within the context of Rarotonga and the overall Cook Islands.

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Appendices

Appendix A: The Pacific Science for Health Literacy Project Questionnaire

Pacific Science for Health Literacy Partnership Programme

Student Questionnaire – Cook Islands T1

To be completed by the researcher			
Researcher Code		Date of completion of questionnaire	
Parental consent has been obtained		Student Assent has been obtained	

Thank you for taking part in this questionnaire.

The researcher will take your group through the questionnaire to make sure you understand what each question is about.

You can ask the researcher a question if you are not sure what to do.

Section One: About You

Please confirm by a tick or a cross whether this information is correct.
You can make any changes in the box on the right hand side of the table.

This information is from your consent form		***ü*** *or* ***û***	*Incorrect – please change to…….*
1. Name			
2. Date of Birth			
3. School			
4. Village Name			
5. Vaka / Island			
6. I am in ……			
7. Sex			
8. How old are you			

Section Two: About Health

	Very Good	Good	OK	Bad	Very Bad
10. My own health is.....					

	Very healthy	Healthy	OK	Unhealthy	Very Unhealthy
11. My lifestyle is usually....					
12. The food I eat is usually...					

	A lot	Some	Not very much	Not at all
13. How much does it matter what you eat?				
14. How much does it matter whether you are active or exercise every day?				
15. How much does it matter whether you are healthy?				

For each of these statements, tick one box to tell me what you think.....	Strongly Agree	Agree	Disagree	Strongly Disagree	I don't know
16. The food a woman eats when she is pregnant affects the health of her baby					
17. The food a father eats affects the health of his children when they are babies					
18. The food I eat now affects my health in the future					
19. The food I eat now may affect the health of any children I have in the future					
20. The food a woman eats when she is pregnant affects the health of her baby when it is grown up					
21. The food a father eats affects the health of his children when they grow up					
22. It is important for me to eat healthy food no					

Section Three: About Nutrition and eating habits

How many days in an average week do you....	0	1	2	3	4	5	6	7
23. Have something to eat for breakfast?								
24. Sit and share an evening meal/dinner with other family members?								
25. Sit down in front of the TV to have your evening meal/dinner?								
26. Help your Mum or Dad or family prepare dinner?								

	In an average week, on how many <u>days</u> do you eat each food type below:	Never (I don't usually eat this food)	1 day a week	2-3 days a week	4-5days a week	More than 5 days a week
50.	*Fresh fruit* (e.g. Pawpaw, mango, banana) One serving = e.g. one small banana or ¼ of a pawpaw					
51.	*Raw or salad vegetables* (e.g. tomato, lettuce) One serving = ½ cup					
52.	*Cooked green vegetables* (e.g. spinach, rukau, beans) One serving = ½ cup					
53.	*Cooked starchy vegetables* (e.g. taro, kumara, potato, maniota, etc) One serving = ½ cup					
54.	*Red meat* (e.g. beef, mutton, lamb (including mince)) One serving = 100g (the size of a small cell phone)					
55.	Poultry (e.g. chicken breast, tenderloins, drumsticks, or whole chickens) One serving = 100g (the size of a small cell phone)					
56.	Processed meats (e.g. sausages, luncheon sausage, canned corned beef, bacon, ham) *100 gms equals* sausages 1 large or 2 small canned corned beef-2 heaped dessert spoons bacon2-3 rashers ham / luncheon-4-5 medium slices					
57.	*Fresh fish, frozen fish(not coated in batter or breadcrumbs or fried) or canned fish* (e.g. tuna, salmon, sardines) One serving = onesmall tin= 95 grms One medium tin =185 gms Sardines one medium tin = 125 gms					
58.	*Frozen battered or breadcrumbed fish (e.g. breadcrumbed or battered tuna)* One serving = 100g (the size of a small cell phone)					
59.	*Grains, Pasta and Cereal foods* (e.g. pasta, rice, muesli, porridge or breakfast cereal – weetbix, cornflakes etc.) One serving = ½ cup					
60	*Milk* plain/un-flavoured (includes milk for drinking only not milk on breakfast cereal) One serving = one cup					

	In an average DAY, how many SERVINGS do you eat each food type below:	Never (I don't usually eat this food)	1 PER DAY	2-3 A DAY	4-5 A DAY	More than 5 a day
61.	*Fresh fruit* (e.g. Pawpaw, mango, banana) One serving = e.g. one small banana or ¼ of a pawpaw					
62.	*Raw or salad vegetables* (e.g. tomato, lettuce) One serving = ½ cup					
63.	*Cooked green vegetables* (e.g. spinach, rukau, beans) One serving = ½ cup					
64.	*Cooked starchy vegetables* (e.g. taro, kumara, potato, maniota, etc) One serving = ½ cup					
65.	*Red meat* (e.g. beef, mutton, lamb (including mince)) One serving = 100g (the size of a small cell phone)					
66.	Poultry (e.g. chicken breast, tenderloins, drumsticks, or whole chickens) One serving = 100g (the size of a small cell phone)					
67.	Processed meats (e.g. sausages, luncheon sausage, canned corned beef, bacon, ham) *100 gms equals* sausages 1 large or 2 small canned corned beef-2 heaped dessert spoons bacon2-3 rashers ham / luncheon-4-5 medium slices					
68.	*Fresh fish, frozen fish(not coated in batter or breadcrumbs or fried) or canned fish* (e.g. tuna, salmon, sardines) One serving = onesmall tin= 95 grms One medium tin =185 gms Sardines one medium tin = 125 gms					
69.	*Frozen battered or breadcrumbed fish (e.g. breadcrumbed or battered tuna)* One serving = 100g (the size of a small cell phone)					
70.	*Grains, Pasta and Cereal foods* (e.g. pasta, rice, muesli, porridge or breakfast cereal – weetbix, cornflakes etc.) One serving = ½ cup					
71	*Milk* plain/un-flavoured (includes milk for drinking only not milk on breakfast cereal) One serving = one cup					

	In an average week, on how many days do you eat each food type below:	Never (I don't eat this food)	1 day a week	2-3 days a week	4-5 days a week	More than 5 days a week
72.	*Chocolate milk or other flavoured milk* (e.g. Milo, Nesquik, Wave) One serving = one cup					
73.	*Energy Drinks* (e.g. Powerade, E2, Lift Plus, V, Red Bull) One serving = one cup					
74.	*Regular fizzy or soft drinks* (e.g. Vaiora, Coke, Sprite, Fanta) One serving = one cup					
75.	*Diet fizzy or soft drinks* (e.g. Diet Coke, Sprite Zero) One serving = one cup					
76.	*Juice and fruit drinks* (e.g. Ribena, Raro, Thriftee, Just Juice, fresh fruit/vege juice) One serving = one cup					
77.	*Sweet stuff* (Chocolates, biscuits, cake, sweets, or lollies) One serving = one bar, slice of cake					
77 A	*Doughnuts* One serving = ½ a doughnut					
78.	*Potato chips* (e.g. crisps, burger rings, twisties, corn chips) One serving = 35g (one small packet)					
79.	*Hot chips* (e.g. french fries, wedges, or kumara chips) One serving = ½ plate chips					
80.	*Meat pies, sausage rolls* One serving = one pie or one full-sized sausage roll					
81.	*Sandwiches or filled rolls* One serving = one sandwich or roll					

	On any given day, how many servings do you eat of each of each food type below:	Never (I don't eat this food)	One serving a day	Two servings a day	Three servings a day	Four servings or more a day
82.	Chocolate milk or other flavoured milk (includes "ZAP", Milo, Nesquik, Wave, get the name of the anchor flavoured milk etc.) One serving = one cup					
83.	*Energy Drinks* (e.g. Powerade, E2, ,Gatorade, Lift Plus, Red Bull) One serving = one cup					
84.	*Regular fizzy or soft drinks* (e.g. Vaiora ,Coke, Sprite, Fanta) One serving = one cup					
85.	*Diet fizzy or soft drinks* (e.g. Diet Coke, Sprite Zero) One serving = one cup					
86.	*Juice and fruit drinks* (e.g. Ribena, Raro, Thriftee, Just Juice, fresh fruit/vege juice) One serving = one cup					
87.	*Sweet stuff* (Chocolates, biscuits, cake, sweets, or lollies) One serving = one bar, one slice of cake, two small biscuits					
87 A	*Doughnuts* One serving = ½ a doughnut					
88	*Potato chips* (e.g. crisps, burger rings, twisties, corn chips) One serving = 35g (one small packet)					
89	*Hot chips* (e.g. french fries, wedges, or kumara chips) One serving = ½ plate chips					
90.	*Meat pies, sausage rolls* One serving = one pie or one full-sized sausage roll					
91.	*Sandwiches or filled rolls* One serving = one sandwich or roll					

		Never	Less than once a week	1-2 times	3-4 times	5-6 times	7 times or more
95.	In an average week, how often do you eat fast food or takeaways from places like Burger shops, Hot chicken shops, Pizza shops, Chinese and Indian takeaways or fish and chip shops?						