Evaluating a nutrition education component of the Ka Mau Te WEHI program.

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Greer Gibson

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Abstract

Background: New Zealand has high rates (32%) of obesity amongst the adult population; Māori (50.2%) and Pacific (68.7%) populations are most affected. Lifestyle interventions are effective in achieving weight loss, but are often expensive, whilst group and online lifestyle interventions are more cost effective.

Objectives: To develop and assess a component of the nutrition education content for the Internet team-based, incentivised behaviour change Ka Mau Te WEHI weight loss intervention for Māori and Pacific adults BMI ≥30 kg/m^2 at risk of or with T2DM and/or cardiovascular disease.

Methods: Three Internet team-based competitions were conducted in New Zealand's North Island, with seven teams of up to seven participants (n=146) per region. The nutrition education was developed to address key eating behaviours associated with increased risk of weight gain and improve nutrition literacy. The education delivered through daily tips on the website and weekly challenges. Eating behaviours and nutrition literacy were assessed at baseline and six-months.

Results: Although 143 participants started the program; only 41.1% (n=60) completed it. Key eating behaviours changed; 18.3% decrease in drinking one or more sugar sweetened beverages/day, mean days eating fast food decreased by -1.7±2 days (*p<0.001)*; mean days eating fruit +1±1.8 (*p<0.001*) and vegetables +0.8±2 (*p=0.006*) increased significantly. Weight loss was not significant between baseline and six months [-4.5±17.3kg (*p*=0.115)].

Conclusion: Although this program was attractive to the target population, a high dropout rate was evident and clinically significant weight loss was not achieved. Despite this, the innovative approach used for nutrition education led to significant dietary behaviour changes. Further research to improve retention and build on eating behaviour changes achieved in this at-risk population is warranted.

Key words: Māori, Pacific Islanders, weight loss, lifestyle intervention, obese.

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Abbreviations

AHEAD	Action for Health in Diabetes
ANS	New Zealand Adult Nutrition Survey
BMI	Body mass index
CVD	Cardiovascular disease
DASH	Dietary Approaches to Stop Hypertension
DPP	Diabetes Prevention Program
ILI	Intensive lifestyle intervention
Kg	Kilogram
MoH	Ministry of Health
NHS	New Zealand Health survey
RCT	Randomised control trial
SD	Standard deviation
SES	Socioeconomic status
T2DM	Type two diabetes mellitus
USA	United states of America
WC	Waist circumference
WEHI	Weight loss and Healthy eating Intervention
WHO	World Health Organisation

Chapter 1.0 Introduction

Worldwide the rate of obesity is increasing despite public health interventions (Ng *et al.*, 2014, Swinburn *et al.*, 2011, The GDB obesity collaborators, 2017). New Zealand, has one of the highest rates of obesity in the world. Thirty-two percent of the adult population in New Zealand are obese (Body mass Index (BMI) >30 kg/m^2) with an additional 34.4% overweight (BMI 25-30 kg/m^2) (Ministry of Health, 2017). Māori and Pacific Island populations are most affected by the obesity epidemic. Fifty per cent of Māori and 68.7% of Pacific adult populations are obese (Ministry of Health, 2017).

Obesity has significant health implications. It is associated with increased risk of chronic diseases, such as cardiovascular disease (CVD), Type 2 Diabetes Mellitus (T2DM) and some cancers (The GDB obesity collaborators, 2017, Poirier *et al.*, 2006). Reflecting the high obesity rate and the associated health risks, CVD is a leading cause of mortality in New Zealand (Ministry of Health, 2017). Those of Māori and Pacific Island descent also have higher rates of T2DM than those of New Zealand European decent (Ministry of health, 2016).

Obesity is a lifestyle related disease; the World Health Organisation attributes the increase of energy dense food and decrease of physical activity to the rise in obesity (World Health Organisation, 2016). The simple explanation of chronic weight gain is energy intake greater than energy output. However, the factors affecting both sides of this equation are individual and complex (The GDB obesity collaborators, 2017). These factors include: genetics, sociocultural, biomedical, psychological and involve eating patterns (Sharma and Padwal, 2010).

Key eating behaviours associated with weight gain are; high intake of energy dense foods, sugar sweetened drinks and food, meals prepared outside of the home, large portion sizes, alcohol and disinhibited eating patterns (World Cancer Research Fund and Research, 2007, World Health Organization, 2003). The latest New Zealand Adult Nutrition Survey 2008/09 (ANS) highlighted portion sizes, sugar-sweetened beverage and fast food consumption as areas of concern for New Zealand's Māori and Pacific Island

populations (Parnell *et al.*, 2011). Additionally, in the 2016/17 New Zealand health survey Māori (33.2%) and Pacific islanders (30.8%) were less likely to meet recommendations for fruit and vegetable intake than other ethnicities (38.8%).

In response to the global rise of obesity and to aid the prevention of chronic disease associated with obesity, the World Health Organisation has called for a focus on nutrition and physical activity (World Health Organization, 2003). Lifestyle interventions have been found to be most successful with the combination of nutrition, physical activity, individual weight loss counselling, prescribed meal plans and prolonged follow-up involvement (Wing *et al.*, 2011, Wadden *et al.*, 2011, Johns *et al.*, 2014, Kirk *et al.*, 2011). There are several ways to achieve weight loss if first line lifestyle interventions are not successful. Including weight loss medications and surgeries. Medications such as Metformin and Orlistat can also help to promote weight loss both on its own or coupled with lifestyle interventions (Wadden *et al.*, 2005, Swinburn *et al.*, 2005). Medical interventions for obesity such as bariatric surgery can successfully help individuals to lose a significant amount of weight and reduce their risk of obesity related chronic disease (Sjöström *et al.*, 2004). However, all of these interventions require high levels of individual support and are expensive by design and therefore limited in applicability to tackle the larger public health concern of obesity (Dutton and Lewis, 2015).
In regards to the dietary component of lifestyle interventions many approaches have been explored such as high protein, low carbohydrate and low fat diets (Klemsdal *et al.*, 2010, Sacks *et al.*, 2009, Shai *et al.*, 2008, Gardner *et al.*, 2007). However, interventions that achieve a calorie deficit achieve similar levels of weight loss despite differences in macronutrient composition (Johnston *et al.*, 2014).

There is a lack of literature that focuses on lifestyle interventions specifically for Māori and Pacific adults within New Zealand. The lifestyle interventions that have been conducted in this area have achieved modest reductions in T2DM incidence (Coppell *et al.*, 2009) and weight (McAuley *et al.*, 2003).

For Māori and Pacific it is important to consider culturally relevant models of health. Te Whare Tapa Whā was developed my Sir Mason Durie (Durie, 1994). This model is based

on the values of the Māori culture. This model of health includes taha tinana (physical health), taha whānau (family health), taha wairua (spiritual health) and taha hinegaro (mental health). Fonua is Pacifica model developed from Te Whare tapa Whā by Sione Tu ‘itahi (Tu'itahi, 2007).

Culturally tailored lifestyle interventions have been successful in achieving weight loss and behaviour change (McCurley *et al.*, 2017). Additional considerations to Māori and Pacifica models of health are models that help to explain behaviour change. Icek Ajzen (2006) has developed a theory of planned behaviour that highlights both an individuals’ attitude toward a specific behaviour and the ability to make a behaviour change. In this theory, knowledge, cultural and social norms affect an individual’s attitude toward a specific behaviour. As the Māori and Pacific populations display eating behaviours associated with weight gain these eating behaviours may have become the social and culture norms. Understanding social and cultural norms of a target population for public health interventions is important in order to appropriately tailor the intervention.

There is a gap in the literature on Māori and Pacific lifestyle and weight loss interventions. This study will move to fill this gap by providing a culturally salient innovative team based weight loss program, incorporating key considerations from Te Whare Tapa whā. The nutrition education component of this intervention will aim to increase knowledge, food literacy and change key eating behaviours to reduce weight and chronic disease risk. The outcome and analysis of this study will provide invaluable knowledge to the area of Māori and Pacific health within New Zealand. Furthermore it will provide insights into culturally tailored weight loss interventions which could be applied to public health interventions for cultural and ethnic minorities worldwide.

1.1 Aim of this sub study

The obesity rates within New Zealand are steadily rising, especially within the Māori and Pacific Island populations. There is an immediate need for further development of public health interventions to meet the needs of these populations. The cost effectiveness of Internet based interventions makes them a useful approach for interventions to reach a

large number of people. The Ka Mau Te WEHI program is an online, team based, incentivised lifestyle program for Māori and Pacific adults. Te Whare Tapa Whā developed by Sir Mason Durie was utilised in the design of this program. The aims and objectives of the Ka Mau Te WEHI program have been previously described (Glover *et al.*, 2017).

As a component of lifestyle interventions nutrition education is important. Nutrition education should address the eating behaviours identified in the target population, incorporate cultural foods and encourage a calorie deficit. Nutrition education must also be developed to consider the participants as a whole. Key considerations are cultural and social norms. Physical activity is an essential component of lifestyle interventions. However, assessment of the physical activity component of this intervention is outside the scope of this sub-study.

Therefore, the aim of this sub-study is to develop and assess a component of the nutrition education content for the Internet team-based, incentivised behaviour change Ka Mau Te WEHI weight loss intervention in Māori and Pacific Island adults, BMI ≥30 kg/m^2 at risk of or with T2DM and/or cardiovascular disease.

Objectives

- To develop selected nutrition education topics for the WEHI weight loss intervention aiming to improve nutrition literacy and eating behaviours
- To assess the change in nutrition literacy achieved using the developed content.
- To assess change in eating behaviours achieved using the developed content.
- To assess the acceptability of the developed nutrition education component within the WEHI weight loss intervention.

1.2 Structure of thesis

Chapter one sets the scene and outlines the justification, aims and objectives of this sub-study to the Ka Mau Te WEHI program. Chapter two is presented as a manuscript and is a narrative review of the literature on current knowledge around lifestyle interventions for obesity, and specifically for Māori and Pacific obese adults. Chapter three is presented as

a research manuscript providing the results of the intervention between baseline and six-months, utilising the newly developed nutrition education component of the Ka Mau Te WEHI program. Chapter four concludes the main findings of this study and how they relate to current knowledge in this area. It further presents the strengths and limitations of this sub-study and recommendations for further research. Appendices include questionnaires, study protocols and supplementary results.

1.3 Contribution of researchers

Researcher	Contribution to research:
Greer Gibson Msc Nutrition & Dietetics student	Responsible for content development of selected aspects of the nutrition education component, anthropometric measurements, conducting focus groups, data entry, data and statistical analysis. Interpretation of results, thesis author.
A/ Prof Rozanne Kruger	Main supervisor Supervision of research development and conceptualisation of the nutrition education component. Supervised data entry and analysis, interpretation and revision and approval of thesis.
Prof Marewa Glover	Co supervisor. Lead investigator, Ka Mau Te WEHI program. Research design of the Ka Mau Te WEHI program and ethical submission. Revision and approval of thesis.
Prof Bernhard Breier	Supervision of research development.
Jane Stephen	Responsible for coordination of the regional managers, anthropometric measurements, focus group sessions and data capturing and checking.
Marrit Nolte Annette Kira Geoff Kira Sally Wong	Ka Mau Te WEHI research team

References

Ajzen, I. 2006. Behavioral interventions based on the theory of planned behavior: Brief description of the theory of planned behavior.

Coppell, K. J., Tipene-Leach, D. C., Pahau, H. L. R., Williams, S. M., Abel, S., Iles, M., . . . Mann, J. I. 2009. Two-year results from a community-wide diabetes prevention intervention in a high risk indigenous community: The Ngati and Healthy project. *Diabetes Research and Clinical Practice,* 85**,** 220-227. Available: DOI 10.1016/j.diabres.2009.05.009.

Durie, M. 1994. *Whaiora: Maori health development.* Auckland, Oxford University Press.

Dutton, G. R. & Lewis, C. E. 2015. The Look AHEAD Trial: Implications for Lifestyle Intervention in Type 2 Diabetes Mellitus. *Progress in Cardiovascular Diseases,* 58**,** 69-75. Available: DOI 10.1016/j.pcad.2015.04.002.

Gardner, C. D., Kiazand, A., Alhassan, S., Kim, S., Stafford, R. S., Balise, R. R., . . . King, A. C. 2007. Comparison of the Atkins, Zone, Ornish, and LEARN diets for change in weight and related risk factors among overweight premenopausal women: The A to Z weight loss study: A randomized trial. *Journal of the American Medical Association,* 297**,** 969-977. Available: DOI 10.1001/jama.297.9.969.

Glover, M., Kira, A., Kira, G., Mcrobbie, H., Breier, B. H., Kruger, R., . . . Funaki-Tahifote, M. 2017. An innovative team-based weightloss competition to reduce cardiovascular and diabetes risk among Māori and Pacific people: rationale and method for the study and its evaluation. *BMC Nutrition,* 3**,** 78. Available: DOI 10.1186/s40795-017-0199-2.

Johns, D. J., Hartmann-Boyce, J., Jebb, S. A. & Aveyard, P. 2014. Research: Diet or Exercise Interventions vs Combined Behavioral Weight Management Programs: A Systematic Review and Meta-Analysis of Direct Comparisons. *Journal of the Academy of Nutrition and Dietetics,* 114**,** 1557-1568. Available: DOI 10.1016/j.jand.2014.07.005.

Johnston, B. C., Kanters, S., Bandayrel, K. & Et Al. 2014. Comparison of weight loss among named diet programs in overweight and obese adults: A meta-analysis. *JAMA,* 312**,** 923-933. Available: DOI 10.1001/jama.2014.10397.

Kirk, S. F. L., Penney, T. L., Mchugh, T. L. & Sharma, A. M. 2011. Effective weight management practice: a review of the lifestyle intervention evidence. *International Journal Of Obesity,* 36**,** 178. Available: DOI 10.1038/ijo.2011.80.

Klemsdal, T. O., Holme, I., Nerland, H., Pedersen, T. R. & Tonstad, S. 2010. Effects of a low glycemic load diet versus a low-fat diet in subjects with and without

the metabolic syndrome. *Nutrition, Metabolism and Cardiovascular Diseases,* 20**,** 195-201. Available: DOI 10.1016/j.numecd.2009.03.010.

McAuley, K. A., Murphy, E., Mclaymsc, R. T., Chisholmphd, A., Storybphed, G., Mann, J. I., . . . Goulding, A. 2003. Implementation of a successful lifestyle intervention program for New Zealand Maori to reduce the risk of type 2 diabetes and cardiovascular disease. *Asia Pacific J Clin Nutr,* 12**,** 423-426.

McCurley, J. L., Gutierrez, A. P. & Gallo, L. C. 2017. Diabetes Prevention in U.S. Hispanic Adults: A Systematic Review of Culturally Tailored Interventions. *American Journal of Preventive Medicine,* 52**,** 519-529. Available: DOI https://doi.org/10.1016/j.amepre.2016.10.028.

Ministry of Health 2016. Annual update of key results 2015/16: New Zealand Health Survey. *In:* Ministry of Health (ed.). Wellington.

Ministry of Health 2017. New Zealand Health Survey. Annual data explorer.: Ministry of Health. Available: https://minhealthnz.shinyapps.io/nz-health-survey-2016-17-annual-data-explorer/_w_e927e4c2/ - !/explore-topics.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., . . . Gakidou, E. 2014. Articles: Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet,* 384**,** 766-781. Available: DOI 10.1016/S0140-6736(14)60460-8.

Parnell, W., Wilson, N., Thomson, C., Mackay, S. & Stefanogiannis, N. 2011. A Focus on Nutrition: Key Findings of the 2008/09 New Zealand Adult Nutrition Survey. *Ministry of Health: Wellington, New Zealand.*

Poirier, P., Giles, T. D., Bray, G. A., Hong, Y., Stern, J. S., Pi-Sunyer, F. X. & Eckel, R. H. 2006. Obesity and Cardiovascular Disease: Pathophysiology, Evaluation, and Effect of Weight Loss. *Circulation,* 113**,** 898.

Sacks , F. M., Bray , G. A., Carey , V. J., Smith , S. R., Ryan , D. H., Anton , S. D., . . . Williamson , D. A. 2009. Comparison of Weight-Loss Diets with Different Compositions of Fat, Protein, and Carbohydrates. *New England Journal of Medicine,* 360**,** 859-873. Available: DOI 10.1056/NEJMoa0804748.

Shai , I., Schwarzfuchs , D., Henkin , Y., Shahar , D. R., Witkow , S., Greenberg , I., . . . Stampfer , M. J. 2008. Weight Loss with a Low-Carbohydrate, Mediterranean, or Low-Fat Diet. *New England Journal of Medicine,* 359**,** 229-241. Available: DOI 10.1056/NEJMoa0708681.

Sharma, A. M. & Padwal, R. 2010. Obesity is a sign - Over-eating is a symptom: An aetiological framework for the assessment and management of obesity. *Obesity Reviews,* 11**,** 362-370. Available: DOI 10.1111/j.1467-789X.2009.00689.x.

Sjöström, L., Lindroos, A.-K., Peltonen, M., Torgerson, J., Bouchard, C., Carlsson, B., . . . Wedel, H. 2004. Lifestyle, Diabetes, and Cardiovascular Risk Factors 10 Years after Bariatric Surgery. *New England Journal of Medicine,* 351**,** 2683-2693. Available: DOI 10.1056/NEJMoa035622.

Swinburn, B. A., Carey, D., Hills, A. P., Hooper, M., Marks, S., Strauss, B. J., . . . Caterson, I. D. 2005. Effect of orlistat on cardiovascular disease risk in obese adults. *Diabetes, Obesity and Metabolism,* 7**,** 254-262. Available: DOI 10.1111/j.1463-1326.2004.00467.x.

Swinburn, B. A., Sacks, G., Hall, K. D., Mcpherson, K., Finegood, D. T., Moodie, M. L. & Gortmaker, S. L. 2011. The global obesity pandemic: shaped by global drivers and local environments. *The Lancet,* 378**,** 804-814. Available: DOI https://doi.org/10.1016/S0140-6736(11)60813-1.

The Gdb Obesity Collaborators 2017. Health effects of overweight and obesity in 195 countries over 25 years. *The New England Journal of Medicine***,** 13.

Tu'itahi, S. 2007. Fonua, a Pacific model. Hauroa newsletter: Hauora.

Wadden , T. A., Berkowitz , R. I., Womble , L. G., Sarwer , D. B., Phelan , S., Cato , R. K., . . . Stunkard , A. J. 2005. Randomized Trial of Lifestyle Modification and Pharmacotherapy for Obesity. *New England Journal of Medicine,* 353**,** 2111-2120. Available: DOI 10.1056/NEJMoa050156.

Wadden, T. A., Volger, S., Sarwer, D. B., Vetter, M. L., Tsai, A. G., Berkowitz, R. I., . . . Moore, R. H. 2011. A Two-Year Randomized Trial of Obesity Treatment in Primary Care Practice. *New England Journal of Medicine,* 365**,** 1969-1979. Available: DOI 10.1056/NEJMoa1109220.

Wing, R. R., Lang, W., Wadden, T. A., Safford, M., Knowler, W. C., Bertoni, A. G., . . . Wagenknecht, L. 2011. Benefits of Modest Weight Loss in Improving Cardiovascular Risk Factors in Overweight and Obese Individuals With Type 2 Diabetes. *Diabetes Care,* 34**,** 1481.

World Cancer Research Fund & Research, A. I. F. C. 2007. *Food, nutrition, physical activity, and the prevention of cancer: a global perspective*, Amer Inst for Cancer Research.

World Health Organisation. 2016. *Obesity and Overweight* [Online]. Geneva: World health Organization. Available: http://www.who.int/mediacentre/factsheets/fs311/en/ [Accessed 28/06/2016 2016].

World Health Organization. 2003. *Diet, nutrition and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation.* Geneva.

Chapter 2.0 Literature review

Prepared in accordance to author guidelines for Nutrition Reviews

Narrative Literature review of the nutrition education component of weight loss interventions for obese Māori and Pacific Island adults in New Zealand

Greer Gibson, BSc Hunt; Rozanne Kruger, PhD, NZRD; Marewa Glover PhD.

College of Health, Massey University, Auckland, New Zealand

2.1 Introduction

Obesity is now considered an epidemic and the rate of obesity is steadily rising. Up to a sixth of individuals in most countries are now categorized as obese, despite public health efforts (Ng *et al.*, 2014, Swinburn *et al.*, 2011, The GDB obesity collaborators, 2017). The high and increasing level of obesity has led to concerns regarding its direct and indirect effects on health. The direct effects include metabolic disturbances such as inflammation and insulin resistance as well as physiological disturbances such as increased blood pressure. Indirect effects include elevated risks for chronic diseases such as Type 2 Diabetes Mellitus (T2DM), some cancers and, in particular, cardiovascular disease (CVD) (The GDB obesity collaborators, 2017).

This literature review first summarises research regarding obesity and obesity related disease globally, and within New Zealand. There is a specific focus on the effect that obesity has on Māori and Pacific adults living in New Zealand. The second half of the review evaluates evidence for the efficacy of nutrition intervention strategies to improve food literacy, eating behaviour, achieve weight loss and ultimately reduce chronic disease risk. The specific eating behaviours and cultural needs of Māori and Pacific obese adults living within New Zealand will also be discussed in regards to providing culturally salient and relevant nutrition interventions for these populations.

The literature review was based on a comprehensive search of available literature. Online databases such as Sciencedirect, Pubmed and Google Scholar were the primary sources of literature, as these provide access to a considerable body of peer-reviewed research in the areas of interest of this study. Searches were conducted using key words relevant to the focus of this study, such as: weight loss, weight loss intervention, nutrition intervention, lifestyle weight loss intervention, nutrition education, obese, overweight, Māori, Pacific. These keywords were also used in combination using 'AND' 'OR'. Manual searches were also conducted using references from recent review articles. Finally, a range of New Zealand government sources were accessed directly in order to obtain relevant epidemiological and public health policy data. These included the Ministry of Health and Statistics New Zealand.

2.2 Obesity

Obesity has been traditionally defined and measured in relation to the Body Mass Index [BMI]. This figure is based on dividing an individual's weight (kg) by the square of their height (m^2). BMI is strongly correlated with body fat content in adults and is a useful and effective tool to assess disease risk associated with excess adipose tissue (Huxley *et al.*, 2010). To support its use in evaluating individual health risk, the World Health Organisation (WHO) has devised three levels of categorization of BMI, as shown in **Table 1:** (World Health Organisation, 2000).

Table 1. Measuring obesity by BMI and waist circumference

	Body mass index	Obesity class	Disease risk	
			Men <102cm Women <88cm	Men >102cm Women >88cm
Underweight	<18.5			
Normal range	18.5-24.9			
Overweight	24.9-29.9		Increased	High
Obesity	30.0-34.9	I	High	Very high
	35.0-39.9	II	Very high	Very high
Extreme obesity	>40.0	III	Extremely high	Extremely high

Adapted from the national Heart and Lung Institute (National Heart Lung and Blood Institute, 2017)

In order to improve its diagnostic use for individuals in the overweight and obese categories, it is recommended that the BMI be used in conjunction with a waist circumference (WC) measure (Cameron *et al.*, 2009). The WC measurement identifies excess abdominal adiposity, which increases the risk of chronic disease additional to the risk associated with a high BMI (Pi-Sunyer, 2005, Cameron *et al.*, 2009). The public health concerns related to obesity are particularly relevant to New Zealand. New Zealand has the third highest rate of obesity worldwide. Thirty-two per cent of the adult population are obese, with a further 35% overweight (Ministry of Health, 2017). As a result, New Zealanders have high levels of chronic disease related to obesity. For instance, cardiovascular disease (CVD) is the third largest cause of mortality and morbidity within New Zealand with 33% of deaths annually caused by CVD (Ministry of Health, 2015b). These negative impacts of obesity are especially found within the Māori and Pacific populations, where levels of obesity are significantly higher than among other ethnic groups. Fifty percent of Māori and 68.7% of Pacific Island adults fall into the obese category, compared to 32.2% of New Zealand European adults (Ministry of Health, 2017).

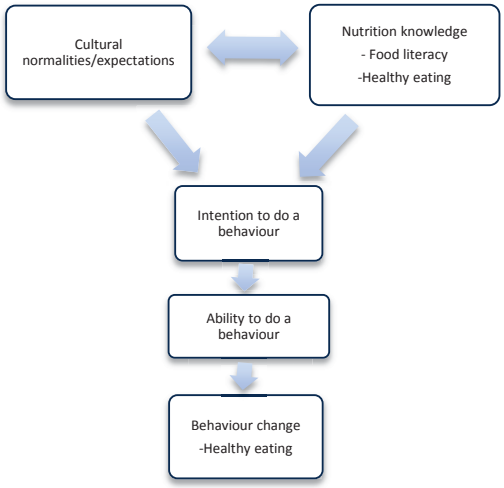
There are many factors in the aetiology of obesity; therefore, the cause is multifactorial and individual (The GDB obesity collaborators, 2017). Factors associated with obesity are genetics, socioeconomic status (SES), food behaviour and sedentary lifestyle. Some risk factors cannot be altered such as age, gender and ethnicity (Everson *et al.*, 2002, The GDB obesity collaborators, 2017). One of the key factors is SES as an individual's environment plays a role in food behaviour and environment and the ability to make healthy food choices (Sharma and Padwal, 2010, Spiegelman and Flier, 2001). The populations of concern for this literature review are over-represented within the low SES population (Ministry of Health, 2015c).

As the general principle of weight gain includes an energy imbalance; intake and activity are the key factors associated with weight gain (Hanson and Gluckman, 2014). The Western obesogenic environment has resulted in increased energy intake and decreased energy expenditure. Combined with genetic factors this has played a key role in the high rate of obesity (Swinburn *et al.*, 2011).

As a result of New Zealand's history of colonization and urbanization, there are some of the highest disease specific disparities in the world (Bramley *et al.*, 2004). Through colonization Māori have lost access to traditional food sources, been culturally repressed and have experienced disparities in access to healthcare and determinants of health (Mason Durie, 2001). As discussed, two of the health risks associated with obesity are CVD and T2DM (Huxley *et al.*, 2010, The GDB obesity collaborators, 2017). Māori adults have a risk of CVD twice that of the New Zealand European population (Ministry of health, 2016). Māori and Pacific adults are 1.9 and 3.39 times more likely to be diagnosed with T2DM than non-Māori or non-Pacific respectively (Ministry of health, 2016). These disparities are also experienced by the Pacific population in New Zealand, with 27.0% living in severe hardship as compared to 8.0% of the total population (Ministry of Health, 2014).

A key factor in weight gain; high-energy intake, has been identified to result from key dietary behaviours. These include; high intake of energy dense foods, sugar sweetened drinks and foods, meals prepared outside of the home, large portion sizes, alcohol and disinhibited eating patterns. (World Cancer Research Fund and Research, 2007, World Health Organization, 2003). For Māori and Pacific adults the key nutritional concerns are: high intake of fast food, sugar sweetened beverages and large portion sizes as identified from the latest Adult Nutrition Survey (ANS) 2008/09 (Ministry of Health, 2012a, Ministry of Health, 2012b, Parnell *et al.*, 2011). Māori and Pacific adults are also 30.0% more likely to be inactive than non-Māori or non-Pacific adults (Ministry of health, 2015a). Additionally, from the latest New Zealand Health Survey (NHS) 2016/17 fewer Pacific and Māori adults met the recommendations for daily vegetable intake. With <60% and <50% respectively meeting the recommendations as compared to non-Pacific adults or non-Māori adults (49.5-72%). The latest ANS 2008/09 found that Māori adults have a 10% higher intake of fat than non-Māori adults and the energy intake of Pacific adult males is 12% higher than non-Pacific Males. Māori and Pacific adults also have a lower rate of daily breakfast consumption 48.5% and 45.2% respectively as compared to 66.9% the total population (Ministry of Health, 2012a, Ministry of Health, 2012b).

With the knowledge that these key behaviours affect weight it is important to understand why these behaviours are being performed. The theory of planned behaviour is a model that is used to understand the influencers on an individual's intention to perform a behaviour or action. This model was developed by Icek Ajzen (Ajzen, 2006). For the context of this study I have used this model to create a conceptual framework adapted from Icek Ajzens Theory of planned behaviour **Figure 1:**



Adapted from Icek Ajzens theory of planned behaviour (Ajzen, 2006)

Figure 1. Conceptual framework for behaviour change

An individual's intention to perform a behaviour is influenced by the following factors: behavioural beliefs, normative beliefs and control beliefs. Normative beliefs result from social and cultural norms. Therefore if it is normal in an individual's social environment to drink soft drinks rather than water they are more likely to do so.

The beliefs that an individual has about a behaviour result in either a positive or negative attitude toward the behaviour. This attitude then influences whether the individual has an intention to perform the behaviour or make a behaviour change.

A strong intention to perform a behaviour, results in an expectation that the individual would perform the behaviour given the opportunity. However, this is reliant on enough actual control of ability to so. For example an individual may want to exercise but not have a safe location accessible to them to do so.

2.3 Weight loss Interventions

Weight loss of 5-10% of bodyweight is effective in reducing chronic disease risk and reducing co-morbidities associated with obesity such as T2DM and CVD (Van Gaal *et al.*, 2005, Goldstein, 1992, Brown *et al.*, 2016). However, there have been few studies in participants with T2DM, the focus of these studies have primarily been on chronic disease prevention rather than reduction of risk in those with chronic disease. A recent study explored this gap by conducting a large (n=5145) observational analysis of participants in the Look AHEAD (action for health in diabetes) study. Additional to overall weight loss, Wing et al, 2011 found that compared to weight stable participants those who lost 5-10% their baseline weight through lifestyle interventions were more likely to achieve clinically significant changes to CVD risk factors. This study despite being observational has shown that the common recommendation to lose 5-10% of body weight can be effective, not only to help prevent T2DM but also for overweight and obese individuals with T2DM to improve glycaemic control and reduce CVD risk markers.

The strategies used to achieve weight loss are within three tiers. Lifestyle intervention is the first line approach; if this is unsuccessful weight loss drugs can be implemented and finally surgical intervention (Ministry of Heath, 2017). In regards to lifestyle interventions the general principle to achieve weight loss is to achieve an energy deficit i.e. energy in is less than energy out. Weight loss medications increase energy expenditure, decrease appetite or decrease intestinal absorption. Bariatric surgery either reduces stomach size or bypasses part of the stomach and intestine. The most effective lifestyle interventions have been found to include both diet and exercise (Kirk *et al.*, 2011, Loveman *et al.*, 2011). Weight loss medications when coupled with lifestyle interventions have been shown to achieve weight loss additional to that of lifestyle interventions alone (Wadden *et al.*, 2005). A randomised control trial investigated the effect of weight loss medications combined with lifestyle intervention on 10-year cardiovascular disease risk in obese Australian and New Zealand adults (n=339) as compared to placebo (Swinburn *et al.*,

2005). Weight loss drugs achieved significantly greater weight loss -4.7±7.7kg as compared to placebo -0.9±4.2 (*p=0.001)* at on year.

Bariatric surgery is a weight loss treatment generally for obese class II and III individuals with obesity related co morbidities (Chang *et al.*, 2014, Colquitt *et al.*, 2014). It is effective in achieving and maintaining weight loss and subsequently reducing chronic disease progression. It is an expensive intervention with risk associated with a surgical procedure. Furthermore, bariatric surgery requires a lifelong adherence to a restricted eating pattern (Sjöström *et al.*, 2004, Martins *et al.*, 2011). Post bariatric surgery multi-vitamins are need for life, protein is recommended to make up the majority of intake and carbohydrates are restricted.

Lifestyle interventions are the first line treatment for obesity and chronic disease risk. Therefore this literature review will focus on this approach to obesity treatment, specifically the dietary component of combined lifestyle interventions.

2.4 Lifestyle interventions for weight loss

The most effective lifestyle intervention to achieve clinically significant weight loss has been challenged. The basic model that energy in should be less than the energy expended can be met by either physical activity or diet alone. However, the combination of dietary advice with physical activity has been explored in a number of studies. The common result is lifestyle interventions including both diet and exercise provide greater weight loss results than either on their own (Wu *et al.*, 2009, Kirk *et al.*, 2011). **Table 2:** shows the factors within combined lifestyle interventions that produce this result and their effect on weight loss and chronic disease risk reduction.

Table 2. Summary of studies investigating combined lifestyle intervention for weight loss and obesity related chronic disease outcomes

Reference Location	Study design Participants	Intervention	Results
(Wadden *et al.*, 2011) United States	RCT N=390 BMI: 30-50(kg/m^2) 2 of 5 components of metabolic syndrome	Randomised to usual care from primary care provider or brief lifestyle counselling or enhanced brief lifestyle counselling (inclusion of Orlistat or Sibutramine or meal replacements after one month of treatment). Same dietary and exercise goals for all interventions. Primary outcome: weight loss at 24months.	At 24-months, no significant difference in weight loss between usual care and brief lifestyle counselling -1.7±0.7kg and -2.9±0.7kg (*P=0.22).* A significant difference between usual care and enhanced lifestyle counselling -1.7±0.7kg and -4.6±0.7kg (*P=0.003).* 6-months a significant difference in weight loss between usual care and brief lifestyle counselling -2.0±0.5kg vs -3.5±0.5kg (*P=0.03).* Conclusion: Lifestyle counselling produced significantly great weight loss at six months only. Enhanced lifestyle counselling achieved greater weight loss at all-time points.
(Bowes *et al.*, 2017) United kingdom	Non-randomised single arm intervention with repeated measures. N=66 BMI 30-39.9(kg/m^2) 18-65years First degree relatives with T2DM	Eight-month lifestyle program including 12 group education sessions led by a dietitian and a weekly exercise program. Primary outcome weight loss at eight months.	At 8-months mean weight loss -10.1±6.0kg (*P<0.001).*
(Lindström *et al.*, 2006) Finland	RCT N=522 (37% from ethnic or racial minorities) BMI ≥25(kg/m^2), Impaired glucose tolerance	Individualised lifestyle counselling, personal sessions with a nutritionist, Individualised exercise programs. Control: General lifestyle advice. Primary outcome: development of T2DM.	Mean weight at one year: 82.2kg intervention, 84.8kg for control *(P<0.0001).* Year three: 83.4kg vs 85.2kg *(P<0.0001).* Incidence of diabetes: 4.3 (95% CI 3.4–5.4) and 7.4 (6.1–8.9) per 100 person-years in the intervention and control group, respectively.
(Wing *et al.*, 2011) United states	Observational analysis N=5145 T2DM BMI ≥25(kg/m^2) 55-76years	Participants were randomly assigned to Intensive lifestyle intervention or diabetes support and education. Lifestyle intervention, calorie target of 1200-1800kcal/day, <30% calories from fat, >15% from protein, ≥175min exercise per week, and behavioural strategies.	The intense lifestyle intervention group achieved a significantly greater (P=<0.0001) mean weight loss of -8.7±7.6Kg as compared to the diabetes support and education group who achieved 0.8±5.0Kg.

The studies included in this table show that combined lifestyle interventions achieve greater weight loss than usual care (Wadden *et al.*, 2011, Wing *et al.*, 2011, Bowes *et al.*, 2017). Additionally, combined lifestyle programs achieve significant reductions in disease progression for T2DM and reduction in risk factors for CVD (Lindström *et al.*, 2006). Interventions including behavioural and or individualised support achieved greater weight loss -8.7kg to -10.1kg (Wing *et al.*, 2011, Bowes *et al.*, 2017). This finding is supported by a recent meta-analysis of RCTs examining the effectiveness of combined behavioural weight loss programs to single component approaches of either diet or physical activity in obese and overweight adults in recent studies (Johns *et al.*, 2014) Pooled results showed significantly greater weight loss in diet and exercise programs that included behavioural support at three to six months (-5.33 kg; 95% CI -7.61 to -3.04) (Johns *et al.*, 2014). A systematic review of diabetes prevention programs in real life environments suggests that a weight loss of -2.32kg (95%CI -2.92 to -1.72) is realistic at 12-months (Dunkley *et al.*, 2014).

Of interest, The Look Ahead Intensive Lifestyle Intervention Group included the use of meal replacement products, these products were provided free of charge to the participants (The Look AHEAD Research Group, 2006). It is reasonable to question whether the calorie restriction achieved would be able to be viable without the use of meal replacements.

Dietary interventions to achieve weight loss have been widely researched, **Table 3*:*** contains recent randomized control trials comparing nutrition interventions with a follow up length of 12-24 months. The interventions include; high protein diets, low carbohydrate diets and low glycaemic load diets. These studies were chosen as randomized control trials (RCTs) as they are the strongest form of intervention. Additionally, weight maintenance is an important measure of success in lifestyle interventions success. Therefore, only studies with a follow up period ≥12 months were included. **Table 4:** Includes meta-analysis of randomized control trials that assess the effect of different dietary interventions on weight loss.

Table 3. Summary of Randomised control trials investigating common dietary manipulations for weight loss

Reference Location	Dietary intervention	Participants	Intervention	Findings
(Klemsdal, 2010) Norway	**Low Glycemic load**	N=202 30-65years, BMI 28-40 (kg/m^2)	RCT. Participants were randomized into low glycemic load or low fat diets; primary endpoint was weight change at 1-year. Low GL 30-35% TE from CHO, 1/3 meal protein, for 2 meals 2/3 vegetables or legumes and 1 meal 1/3 high fibre CHO. Low fat <30% energy from fat. 500kcal deficit from estimate intake was recommended. Dietitian sessions 4 individual + 5 groups sessions.	Fat, protein and CHO intake were significantly different between groups p=0.001. 78% completion in low CHO, 84% completion in low fat group. LGL vs low fat at 6 months only -4.8±3.9 vs. -3.8±3.5 P=0.06. At one year -4.0 vs. -4.3Kg p=0.69. Conclusion: both dietary interventions achieved clinically significant weight loss at 1 year but there was no significant difference in efficacy in energy reduced LGL compared to a low fat diet.
(McMillan-Price *et al.*, 2006) Australia	**Low Glycemic load**	N=129 Adults with a BMI ≥25(kg/m^2)	RCT. Four reduced fat, high fibre diets for 12 weeks. Diet 1 high CHO (55% of TE) high GI (highest GL) Diet 2 High CHO (55% of TE) Low GI Diet 3 high protein (25% TE) high GI Diet 4 high protein (25% TE) low GI (lowest GL) Meal plans 1400kcal for women, 1900kcal for men.	Statistically significant weight loss was achieved by all diets *P<0.001.* Diet 1: -4.2±0.6%, diet 2: -5.5±0.5%, diet 3: 6.2±0.4% and diet 4: -4.8±0.7%. No significant difference in weight loss between groups *P>0.05.* No difference in energy intake between groups p=0.41. No significant difference in fat loss among the 4 diets p=0.75. Significant difference in proportion of participants who lost ≥5% was found; Diet 1: 31%, diet 2: 56%, diet 3: 66%, diet 4: 33%, *P=0.01.* Conclusion: All diets achieved significant weight loss.
(Sacks *et al.*, 2009) United states	**High protein**	N=645 30-70years BMI 25-40 (kg/m2)	Blinded RCT comparing 2year change in weight with 4 dietary interventions; Low fat, moderate protein (fat 20%, protein 15% TE), Low fat high protein (fat 20%, protein 25% TE) High fat average protein (fat 20%, protein 15%) High fat high protein (fat 40%, protein 25% TE). Primary outcome change in weight at 2-years.	There was no significant difference in weight loss between the dietary groups P=0.76. At 2-years diets with 15% protein achieved -3kg and 25% protein -3.6kg no difference between groups *P=0.22*. Only23% of participants continued to lose weight from 6-months to 2 years. At 2 years 31-37% of participants in each diet group had lost at

			750kcal/day calorie deficit. Physical activity goal of 90 minutes/week. 1 group session every 4 weeks, 1 individual session every 8 weeks.	least 5%, 14-15% had lost at least 10%. All diets reduced risk factors for CVD and diabetes. Targets for macronutrient intake were not met. Reported energy intake and PA were similar between groups. Adherence to protein intake in high protein groups and adherence to fat intake in the low fat group was associated with weight loss. (p=0.0001) Attendance to group sessions at 2years (0.2kg for every session attended)
(Wycherley *et al.*, 2012a) Australia	**High protein**	N=120 All males BMI 27-40(kg/m^2)	One year RCT, assigned to isocaloric: High protein low fat (protein 35%, CHO 40% fat 20%) OR High CHO low fat diet (protein 17%, CHO 58%, fat 25%). Energy intake 7MJ/day Individual dietitian sessions at baseline and each 2weeks for 12 weeks and monthly thereafter. Weeks 0-12 participants were provided with key foods (around 60% of intake).	N=68 completed the intervention Good compliance to specific diets, similar energy intake between groups *P*=≥0.05. Weight loss at one year High protein –12.3±8.0kg , high CHO, low fat -10.9±8.6, no significant difference between groups *P*=0.83. The high protein group lost significantly less fat free mass *P*=0.11.
(Brinkworth *et al.*, 2004) Australia	**High protein**	N=66 Adults BMI 27-40(kg/m^2) with T2DM	RCT, assigned to low protein (15% protein, 55% CHO) OR high protein (30% protein 40% CHO) With 8 weeks energy restriction (6.7MJ/d) and 4 weeks energy balance. Fixed menu plans. Dietetics session every 2 weeks until week 12. Participants were asked to maintain the energy balance diet for 12 months follow up.	N=38 completed the program 5.7% weight loss in both groups at 12 weeks. At 64 weeks weight loss was -2.2±1.1kg in the low protein diet and -3.7±1kg in the high protein diet, time effect p=0.01. Greater weight loss in high protein group. There was good compliance to dietary targets.
(Gardner *et al.*, 2007) United states	**Popular diets/low CHO**	N=311 All women BMI 27-40 (kg/m^2)	RCT. Randomised to either the Aitkins diet, Zone, Ornish or LEARN diet. Weekly instruction for 4 weeks and then 10 month follow up. Primary outcome weight loss at 12months	Total energy intake did not differ between groups at any time frame p=≤0.40. Reduced intake from baseline at all time frames across groups. Mean 12-month weight change was; −4.7 kg (95% CI, −6.3 to −3.1 kg) Atkins. −1.6 kg (95% CI, −2.8 to −0.4 kg) Zone, −2.2kg (95% CI, −3.6 to −0.8 kg), LEARN, and −2.6 kg (95% CI, −3.8 to−1.3 kg), Ornish and was significantly different for Atkins vs. Zone. At the 2- and 6-month intermediate time points, the weight

				change for the Atkins group was significantly greater than for all other groups (P≤.05).
(Shai *et al.*, 2008) Israel	**Low CHO/Mediterranean**	N=322 BMI ≥27 (kg/m^2) OR the presence of T2DM OR Coronary Heart Disease	Randomly assigned to 1 of 3 diet groups, for a 2 year intervention. Low fat diet 1500kcal/d women or 1800kcal/d men, 30% fat, 10% saturated fat and 300g cholesterol/day. Participants were counselled to consume low-fat grains, vegetables, fruits and legumes and to limit their consumption of additional fats, sweets and high fat snacks. Mediterranean diet 1500kcal/day women, 1800kcal/day men. Goal of no more than 35% of calories from fat, main source of fat 30-45g of olive oil and handful of nuts. Low CHO diet non-restricted calorie diet 20g of CHO per day, for 2month induction phase, gradual increase to 120g per day to maintain weight loss. Participants were counselled to eat vegetarian protein sources and to avoid trans-fat (based on Aitkins diet). Lunch is typically the main meal in Israel and was provided.18 90-minute group sessions with a dietitian.	Energy intake decreased in all groups over all timeframes from baseline *P*<0.001, with no significant difference between groups. At 24 months, adherence was greatest in the low fat group, 90.4%, as compared to 85.3% and 78.9% in the Mediterranean and low CHO groups respectively *P=0.04*. At 24-months, no significant difference in energy intake between groups. Mean change in energy intake (kcal/day) from baseline was -572.6±1538.0, -371.9±864.2, -550.0±1453.9 *P=0.55*. At 24-months weight change was -2.9±4.2kg in the low fat group, -4.4±6kg the Mediterranean group and -4.7±6.5kg for the Low carbohydrate group *P*<0.001. Conclusion: No clinically significant difference in weight change between groups, all groups achieved significant weight loss.
(Frisch *et al.*, 2009) Germany	**Low CHO**	N=200 BMI ≥25	Randomised control trial, 12-month intervention. Conventional low fat diet (CHO>55%) OR Low CHO diet (CHO<40%). 500kcal deficit recommended for both groups. Weekly nutrition education and telephone dietary counselling	At six months 400kcal deficit in both groups energy intake increased at 12 months but were not significantly difference between groups at any time point *P*>0.05. Macronutrient intake was significantly different between groups at all time periods. At six months low fat -6.2±4.8kg, low CHO -7.2±5.4kg *P>0.05.* At 12 months Low CHO -5.8±6.1kg, low fat -4.3±5.1kg *P*=0.06 76% of weight reduction was due to fat loss. Number of dropouts did not differ between groups p=>0.05. Conclusion: No difference in outcomes between dietary groups.

Table 4. Summary of meta-analysis studies investigating the effect of common dietary interventions.

Reference	Intervention	Study design	Number of trials Participants	Findings
(Naude *et al.*, 2014)	**Low carbohydrate vs. balanced diet**	Systematic review and meta -analysis	N=19 trials, minimum follow up 12 weeks Participants BMI ≥25 With or without co-morbidities	No difference in weight loss in low carbohydrate compared to isocaloric balance diets at three to six months or 12-24 months, -0.74kg (95% CI -1.58, 0.01) (*P=0.05)* Little or no difference in CVD risk factors at 3-6months or 12-24 months.
(Hession *et al.*, 2009)	**Low carbohydrate compared to low fat low calorie diet**	Systematic review of randomized controlled trials	N=13 trials, minimum follow up 6months Participants BMI ≥28	At 6 months weight loss favoured low carbohydrate/high protein, over low fat/ high carbohydrate with a difference of -4.02kg (p=<0.00001) At 12 months this difference was reduced to -1.05kg (p=<0.05), which has little clinical significance.
(Schwingshackl and Hoffmann, 2013)	**Low protein compared to high protein**	Systematic review and meta-analysis of randomized control trials	N=15 trials, minimum follow up 12 months Participants BMI ≥25	High protein intake ranged from 30-50% of total energy intake, low protein intake ranged from 10-20% total energy intake. No statistically significant difference in weight loss comparing low protein to high protein diet (p=0.46)
(Wycherley *et al.*, 2012b)	**Energy restricted high protein/low fat compared to low fat diets**	Meta-analysis of RCTs	N=23 trials included, minimum diet period 4 weeks Participants >18 years	Compared to an isocaloric low fat diet a high protein/low fat diet produce modest benefits in weight loss and fat free mass retention.

The studies included in **Table 3:** and **Table 4:** show that there is no benefit of one macronutrient manipulation to achieve weight loss. For example the two systematic reviews by Hession et al (2009) and Naude et al (2014) comparing low carbohydrate to low calorie diets found that there was no long term significant difference in weight loss achieved from low carbohydrate diets. However, adherence to low carbohydrate and low calorie diets was associated with clinically significant weight loss (Naude *et al.*, 2014, Hession *et al.*, 2009). In studies that achieved calorie restrictions, significant weight loss was achieved -4.7kg at 12 months, -4.3kg at six months and -5.8kg at 12-months respectively (Shai *et al.*, 2008, Klemsdal *et al.*, 2010, Frisch *et al.*, 2009). Therefore, it can be concluded that energy restricted diets produce similar results and there is no one diet that is superior in achieving this.

The key element to weight loss in these studies was calorie restriction. Interestingly, many of these studies provided food and/or meal plans for their participants. Portion controlled and ready-made meal plans and/or food provision have been incorporated into weight loss interventions to make adhering to calorie-restricted diets easier for participants. Meal replacements are often introduced at the start of interventions, and then slowly reducing the amount used until free eating is established. As obesity is a chronic condition that requires long-term treatment, it is important that individuals gain the skills and knowledge to balance their energy intake and output on a daily basis. Therefore, individuals must know how to eat and prepare real food in a healthy way. A review by Heymsfield *et al*. (2003) found that low calorie diets utilizing meal replacement products achieved greater weight loss at 3-months ($p<0.05$) when compared to low calorie diets. However, the difference was not significant at 12-months.

Breakfast consumption

Breakfast consumption has been associated with lower daily energy density, improved overall diet quality and decreased risk of weight gain (Kant *et al.*, 2008). Furthermore, high dietary energy density is associated with increased risk of obesity (Mendoza *et al.*, 2007). However, in regards to weight loss interventions there is less consistent evidence

that breakfast eating improves weight loss. A recent RCT investigated the effect of recommendations to eat or skip breakfast in adults (n=309) trying to lose weight. This study found no interaction between eating breakfast and weight loss despite over 90.0% compliance with recommendations (Dhurandhar *et al.*, 2014). However, this study did not achieve significant weight loss overall. The weight loss intervention was minimal providing only weight loss pamphlets and advise to either consume breakfast or to not (Dhurandhar *et al.*, 2014). Therefore, it is reasonable to suggest that the weight loss intervention was not sufficient to achieve significant weight loss outcomes. Conversely, the National Weight Control Registry found that successful weight loss maintainers more consistently ate breakfast (Wyatt *et al.*, 2002).

A recent randomised parallel arm study, compared a high calorie intake at breakfast with low calorie intake at night as compared to the opposite meal pattern and the effect on weight loss. The high calorie breakfast group had a significantly greater weight loss at 12 weeks (-8.7±1.4kg vs -3.6±1.5kg, $p<0.0001$) (Jakubowicz *et al.*, 2013).

Regularly eating breakfast has been associated with decreased risk of weight gain and there is some evidence to suggest that breakfast can have a beneficial effect in weight loss interventions.

Weight loss maintenance

In the treatment of obesity, weight loss although crucial, is only the first step. Weight loss maintenance is also important. Successful weight loss maintenance is generally considered at 10% loss of body weight at one year (Wing and Phelan, 2005). Within the diabetes prevention program cohort, of those who were assigned the lifestyle program 37% were able to maintain a weight loss of 7% body weight loss or more at the end of follow up. This intervention was an intensive lifestyle intervention including a 16-lesson curriculum delivered individually (Diabetes Prevention Program Research Group, 2002). A meta-analysis of RCT weight loss interventions with follow up ≥1 year, found on average 5-9% of body weight was lost at six months which decreased to 3-6% by four years of follow-up (Franz *et al.*, 2007).

The determinants of successful weight maintenance were explored through the use of the national weight control registry in the United Kingdom Wing et al (Wing and Phelan, 2005). The factors associated with weight maintenance include: consuming a low calorie diet, consuming a low fat diet, doing heavy exercise and consuming breakfast. Registry members are estimated to consume around 1800 kcal/day, 2.5 meals at a restaurant/week and 0.74 meals at fast food establishments/week. The registry members also report frequently monitoring their weight with >70% weighing themselves ≥once/week. Although this list is not exhaustive of the factors associated with long-term weight loss, they provide an interesting guide for what it takes to successfully keep weight off.

2.5 Nutrition education to promote eating behaviour change

Nutrition related education aims to improve eating behaviours through increasing an individual's or groups nutritional knowledge. Whether increased nutritional knowledge results in healthier eating behaviours or not has been debated. Dietitians have extensive nutritional knowledge and therefore in theory should have healthy eating behaviour. This assumption was investigated in a cross-sectional study comparing the nutritional behaviour of 99 dietitians to 117 non-dietitians. Dietitians had a higher use of food labels, greater fruit and vegetable intake and ate less sugar confectionaries, oil and fats (Sugimoto *et al.*, 2016). This suggests that nutritional knowledge does have an effect on food choices and eating behaviour.

A recent systematic review assessed health literacy and compliance to nutritional recommendations. Health literacy was significantly associated with adhering to nutritional recommendations such as a balanced diet and fruit and vegetable intake (Carrara and Schulz, 2017). The studies in this review included mostly health literacy not specifically nutrition literacy. The four key components of health literacy have been established as knowledge, skills and transformation and empowerment (Nutbeam, 2008). However, there has been little consensus on the definition of nutrition literacy. A review of the literature has revealed the following as core themes of nutrition/food literacy:

access, planning and management, preparation, eating, selection, knowing where food comes from, nutrition and language (Vidgen and Gallegos, 2014, Vidgen and Gallegos, 2011). A definition from these themes was developed by Vigden and Gallegos, 2011 "capacity of an individual to obtain, interpret and understand basic food and nutrition information and services as well as the competence to use that information and related services that are health enhancing." This can be broken down into an individual's ability to plan and manage, select, prepare and eat food in a way that promotes health and personal wellbeing.

To improve food literacy, nutrition education is key. However, it is important to consider the nature of eating behaviour. A review by Shulz et al (2013) concluded that the development of both health literacy and empowerment is key to promote behaviour change. This is also relevant to eating behaviour change; nutrition education cannot be delivered without empowering individuals to use knowledge to make informed decisions.

2.6 Cultural considerations for lifestyle interventions

Worldwide there are disparities in health, with ethnic minorities experiencing higher prevalence of overweight weight, obesity and the chronic diseases associated with this. There is also a global trend of low participation in mainstream weight loss programs by ethnic and cultural minorities; within New Zealand it is no different with uptake of main stream weight loss programs low in the Māori and Pacific populations (Glover *et al.*, 2014b, Oster *et al.*, 2006).

With clear discrepancies in health of the Māori and Pacific populations the unique cultural and social needs of these populations should be considered in the design of the interventions (Ministry of health, 2016). This respectful approach will aid the acceptance, uptake and integration of the messages conveyed.

As discussed, lifestyle interventions such as the Diabetes Prevention Program can effectively promote weight loss and reduce risk of chronic disease. However, in the United States these programs have reached fewer of the ethnic minorities than the general population. These interventions were not culturally tailored to different ethnic or

cultural groups within the target populations. Leading to the conclusion that these programs may not be relevant to minorities and not feasible to implement into their lifestyles.

A systematic review of culturally tailored versions of mainstream T2DM prevention interventions in the United States of America (USA) was conducted (McCurley et al., 2017). This review found a moderate effect of culturally tailored interventions on T2DM risk reduction through weight-loss. Of the five studies with the strongest effect sizes, four included literacy modification peer educators and one or more of the following: Hispanic food/recipes, cultural diabetes beliefs, family/friend participation, structured community input, innovative hands-on strategies (McCurley et al., 2017). Weight loss achieved in these studies was 5.6%, 1.3%, 4.4%, 2.2% and 4.1% respectively, which is comparable to weight loss achieved by other lifestyle weight loss interventions at 12 months (Wadden *et al.*, 2011). A limitation of this review is that no studies compared an untailored intervention to a tailored intervention. However, the weight loss achieved suggests that these factors are beneficial to adapt for interventions focusing on ethnic or cultural minorities.

The Māori health strategy identifies that we require culturally relevant interventions to achieve meaningful change in the health of these populations (Ministry of Health, 2002). Te Whare Tapa whā, a well-known model of how Māori view health and wellbeing was developed in 1982 (Mason Durie, 2001). This model of health recognises the four dimensions of health in Māori wellbeing. The dimensions include Wairoa (spiritual health), hinegaro (mental health) and whānau (family health) health in addition to tinana (physical health). From Te Whare tapa whā a Pacifica model of health was developed. Fonua has five dimensions, global/environment, community/national, physical/local, mental/family and spiritual/individual health (Tu'itahi, 2007).

For Māori and Pacific Islanders, health must be addressed on all levels/dimensions to achieve holistic health and a healthy society. The themes of these two models are similar: the physical dimension of health is affected by an individual's overall health, including

whānau (family) health. It is important that these models or similar models be used for direction in the design of healthcare interventions for these population groups.

A recent study by Glover et al, evaluating the WERO stop smoking program, demonstrated the effectiveness of tailoring a public health intervention to the specific needs of the Māori and Pacific populations. This intervention focused on Pacific and rural Māori communities and used the combination of monetary incentives, team based competition and online education and support (Glover *et al.*, 2014a). The study had a verified smoking cessation rate of 26% at six-months (national cessation rate for Māori and Pacific in supported cessation programs at six-months follow up is 19% and 14% respectively) showing the effectiveness of identifying the specific needs of sub groups of a population (Glover et al., 2014).

2.7 Lifestyle interventions Māori and Pacific adults

There is a void in the literature in regards to lifestyle interventions for Māori and Pacific adults, **Table 5:** shows the programs that have been carried out within New Zealand for these populations.

Table 5. Lifestyle interventions for Māori and Pacific Islanders

Reference	Health marker	Design	Participants	Intervention	Findings
(Coppell *et al.*, 2009) East coast North Island New Zealand	Insulin resistance	Process evaluation	Māori N=152	Evaluation of a community led diabetes prevention program Ngati and Healthy. Measured by interrupted time series surveys over a three-year period. OGTT, fasting lipids and urate levels.	Insulin resistance and total diabetes prevalence decreased from 35-25.4% and 12.6%-10.6% respectively (p=0.003). Women aged 25-45 years had a significant increase in PA and wholegrain consumption. No significant weight loss was achieved. There was a larger uptake from women than men n=102 and n=50 respectively.
(Simmons *et al.*, 2008) Waikato, New Zealand	Glucose tolerance, Weight change	Randomised cluster control trial	Māori N=160	Evaluation of the Te Wai o Rona : Diabetes prevention Individual support from a community health worker to achieve 11 lifestyle-goals to prevent diabetes. Outcomes measured at six months.	Weight loss achieved was -1.3±3.6kg (*P<0.001).* N=55 (34.4%) male, n=105 (75.6%) female
(McAuley *et al.*, 2003) Otago, New Zealand	Insulin sensitivity anthropometry	Pre and post intervention comparison	Māori n=36	Evaluation of a 4-month lifestyle program including personalized diet and exercise program	Weight loss of -3.1kg (p=<0.001) Improved insulin sensitivity
(Simmons *et al.*, 1998) Auckland, New Zealand	Anthropometry diabetes knowledge	Prospective non randomized control study	Samoans N=222	Prospective non-randomized control study evaluation the effect of a church based diabetes risk reduction program	Weight remained stable in the intervention group, significant increase in weight in the control group 3.1±-9.8 kg in the control church (*P*=0.05). Significant increase in number regularly exercising in the intervention group +22% vs -8% in control, (*P*<0.05).

Lifestyle interventions for Māori and Pacific Islanders have achieved little or no weight loss. The most significant weight loss was achieved in an intensive lifestyle intervention for Māori with pre-diabetes (McAuley *et al.*, 2003). The participants in this study attained a significant weight loss of 3.1kg in a 4-month intervention. However, there are limitations to this study, firstly it had a small population group n=36. Of greater relevance, the intervention required a significant amount of individual support and individually prescribed dietary programs. This level of support is expensive, is not feasible on a larger scale, and therefore is not likely to be an answer to making meaningful lifestyle changes in New Zealand Māori and Pacific populations (McAuley et al., 2003).

To effectively reach the populations in New Zealand that are most at risk of chronic diseases, the low uptake of weight loss interventions must be overcome in addition to making the intervention itself culturally salient. In a recent systematic review investigating the low rate of enrollment of ethnic and racial minorities in weight loss interventions in the United States, it was found that interventions including smart phone usage and in person contact had higher enrollments of ethnic minorities (Rosenbaum *et al.*, 2017). New Zealand's Māori and Pacific populations are over represented in low SES category and have a higher rate of deprivation (Ministry of Health, 2015c). It has been highlighted that for populations facings these challenges an online program may be better suited to enable access to interventions by providing flexibility around long work hours and/or multiple jobs (Coakley *et al.*, 2012).

2.6 Utilising technology to deliver lifestyle interventions

Internet based lifestyle interventions may be a cost effective approach. The downfall is that many websites and diet programs do not provide science-based education. Of the sites that do provide science based education and programs, a reduction in interaction and high dropout rates have been found to negatively impact the outcomes (Womble et al., 2004, Harvey-Berino et al., 2002). Demonstrating this, Moore et al (2008) conducted a DASH (Dietary Approaches to Stop Hypertension) for health, which included a free and entirely online program to the employees and families of a United States company with nutrition advice. At 12 months, only 26% were still visiting the website, the majority of the dropouts were out by the 2-month marker and the average weight loss at 12-months

for participants with a BMI >25 (overweight) was -4.2lbs (1.9Kg) (Moore et al., 2008). These findings suggest that providing education alone is not adequate to maintain participation and promote lifestyle changes. Therefore, a balance between intensive personalized nutrition education, and counseling and education alone needs to be achieved to provide a cost effective successful weight loss program.

A team based Internet intervention has also achieved significant weight loss 4.2 ± 3.4%, in a 12-week online program for Obese and overweight adults (Leahey *et al.*, 2012).

2.8 Developing the nutrition education content.

To achieve behaviour change in regards to nutrition, an individual must have the intent to make a behaviour change (Ajzen, 2006). The stages of change model can be used to assess an individual's readiness for behavior change (Prochaska, 1997). In addition, traditional models of health must also be considered to support behaviour change within context for specific populations groups. Readiness for behaviour change is in part affected by norms and beliefs, specifically cultural and social norms (Ajzen, 2006). Therefore nutrition education must incorporate the aspects of effective weight loss eating behaviours and simultaneously consider culture norms that may inhibit or promote these eating behaviours. Additionally an individual's ability to perform a behaviour is important (Ajzen, 2006). This is of high relevance to the target population due to the over representation in the low SES (Ministry of Health, 2015c). Mauro et al, (2008) has identified some major barriers to successful obesity treatment in a comprehensive review and highlights the need to address these early to prevent wastage of resources resulting from high dropout rates and to improve long-term success (Mauro et al., 2008). These barriers include: acceptance of obesity as a chronic disease, SES, time constraints, saboteurs, comorbidities, medication, alcohol and substance abuse. Factors that may Sabotage an individual's attempt to make a behaviour change could result from social or cultural norms. For example an individual may be ready to make a change but their household may not.

To develop nutrition education for the target population there are several factors to consider: firstly, national guidelines for weight loss and healthy eating; secondly, the eating behaviors and cultural foods of the target population; and lastly, literacy levels of the target population. Portion size an essential focus of education, to allow interpretation and implementation of widely available resources. Under reporting of energy intake is a common limitation of self-reported intake. Under reporting has also been found to be more likely in overweight or obese individuals as compared to normal weight individuals (Mullaney *et al.*, 2015, Rennie *et al.*, 2007). Specifically in New Zealand in the 2008/09 New Zealand ANS under reporting of energy intake was higher in individuals who were overweight or obese 25.0%, 30.0% as compared to the overall population 16% (*P=0.001)* (Gemming et al., 2014).

2.9 Summary

Throughout this literature review it has been apparent that dietary interventions that achieve a calorie deficit as part of a lifestyle intervention can effectively produce clinically significant weight loss, and reduction in metabolic risk (Wadden *et al.*, 2011, Wing *et al.*, 2011, Sacks *et al.*, 2009, Wycherley *et al.*, 2012a, Shai *et al.*, 2008). Many of these dietary interventions have required intensive programs, including regular individual behaviour change or dietary counseling, and meal replacement products (Shai *et al.*, 2008, Wing *et al.*, 2011). This level of support is expensive, and therefore other mediums for nutrition education have been explored such as Internet based programs. As discussed, the challenge with these interventions is maintaining participation (Womble *et al.*, 2004, Moore *et al.*, 2008). Team-based interventions have been shown to be beneficial in lifestyle interventions (Leahey *et al.*, 2012).

Highlighted by this literature review is that New Zealand Māori and Pacific populations have a high consumption of take-away food and sugar-sweetened beverages, and they eat proportionately larger portion sizes (Ministry of Health, 2012a, Ministry of Health, 2012b). These populations also have a disproportionately lower consumption of fruit and vegetables; have irregular meal patterns (Ministry of Health, 2017). Eating food that is

offered is an important cultural practice integral to social interactions and events (Glover *et al.*, 2017). These are key areas to address with nutrition education to achieve the calorie restriction that is required within a lifestyle intervention to achieve weight loss as highlighted by this review.

A limited number of lifestyle interventions for the target population have been reported in the literature. Furthermore, the ones that have been completed have shown minimal effect. To our knowledge there have been no Internet based team competitions targeting weight loss and healthy eating.

References

Ajzen, I. 2006. Behavioral interventions based on the theory of planned behavior: Brief description of the theory of planned behavior.

Bowes, A., Begley, J. & Kerr, D. 2017. Lifestyle change reduces cardiometabolic risk factors and glucagon-like peptide-1 levels in obese first-degree relatives of people with diabetes. *Journal of Human Nutrition and Dietetics,* 30**,** 490-498. Available: DOI 10.1111/jhn.12440.

Bramley, D., Hebert, P., Jackson, R. & Chassin, M. 2004. Indigenous disparities in disease-specific mortality, a cross-country comparison: New Zealand, Australia, Canada, and the United States. *N Z Med J,* 117**,** U1215.

Brinkworth, G. D., Noakes, M., Parker, B., Foster, P. & Clifton, P. M. 2004. Long-term effects of advice to consume a high-protein, low-fat diet, rather than a conventional weight-loss diet, in obese adults with Type 2 diabetes: one-year follow-up of a randomised trial. *Diabetologia,* 47**,** 1677-1686. Available: DOI 10.1007/s00125-004-1511-7.

Brown, J. D., Buscemi, J., Milsom, V., Malcolm, R. & O'neil, P. M. 2016. Effects on cardiovascular risk factors of weight losses limited to 5–10 %. *Translational Behavioral Medicine,* 6**,** 339-346. Available: DOI 10.1007/s13142-015-0353-9.

Cameron, A. J., Dunstan, D. W., Owen, N., Zimmet, P. Z., Barr, E. L., Tonkin, A. M., . . . Shaw, J. E. 2009. Health and mortality consequences of abdominal obesity: evidence from the AusDiab study. *The Medical Journal of Australia,* 191**,** 202-208.

Carrara, A. & Schulz, P. J. 2017. The Role of Health Literacy in Predicting Adherence to Nutritional Recommendations: a Systematic Review. *Patient Education and Counseling*.

Chang, S., Stoll, C. T., Song, J., Varela, J., Eagon, C. J. & Colditz, G. A. 2014. The effectiveness and risks of bariatric surgery: An updated systematic review and meta-analysis, 2003-2012. *JAMA Surgery,* 149**,** 275-287. Available: DOI 10.1001/jamasurg.2013.3654.

Colquitt, J. L., Pickett, K., Loveman, E. & Frampton, G. K. 2014. Surgery for weight loss in adults. Available: DOI 10.1002/14651858.CD003641.pub4.

Coppell, K. J., Tipene-Leach, D. C., Pahau, H. L. R., Williams, S. M., Abel, S., Iles, M., . . . Mann, J. I. 2009. Two-year results from a community-wide diabetes prevention intervention in a high risk indigenous community: The Ngati and Healthy project. *Diabetes Research and Clinical Practice,* 85**,** 220-227. Available: DOI 10.1016/j.diabres.2009.05.009.

Dhurandhar, E. J., Dawson, J., Alcorn, A., Larsen, L. H., Thomas, E. A., Cardel, M., . . . Allison, D. B. 2014. The effectiveness of breakfast recommendations on

weight loss: a randomized controlled trial. *The American Journal of Clinical Nutrition,* 100**,** 507-513. Available: DOI 10.3945/ajcn.114.089573.

Diabetes Prevention Program Research Group 2002. Reduction in the Incidence of Type 2 Diabetes with Lifestyle Intervention or Metformin. *New England Journal of Medicine,* 346**,** 393-403. Available: DOI 10.1056/NEJMoa012512.

Dunkley, A. J., Bodicoat, D. H., Greaves, C. J., Russell, C., Yates, T., Davies, M. J. & Khunti, K. 2014. Diabetes prevention in the real world: effectiveness of pragmatic lifestyle interventions for the prevention of type 2 diabetes and of the impact of adherence to guideline recommendations: a systematic review and meta-analysis. American Diabetes Association. Available: http://ezproxy.massey.ac.nz/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=edsgea&AN=edsgcl.364578085&site=eds-live&scope=site.

Everson, S. A., Maty, S. C., Lynch, J. W. & Kaplan, G. A. 2002. Epidemiologic evidence for the relation between socioeconomic status and depression, obesity, and diabetes. *Journal of Psychosomatic Research,* 53**,** 891-895. Available: DOI https://doi.org/10.1016/S0022-3999(02)00303-3.

Franz, M. J., Vanwormer, J. J., Crain, A. L., Boucher, J. L., Histon, T., Caplan, W., . . . Pronk, N. P. 2007. Weight-Loss Outcomes: A Systematic Review and Meta-Analysis of Weight-Loss Clinical Trials with a Minimum 1-Year Follow-Up. *Journal of the American Dietetic Association,* 107**,** 1755-1767. Available: DOI http://dx.doi.org/10.1016/j.jada.2007.07.017.

Frisch, S., Zittermann, A., Berthold, H. K., Götting, C., Kuhn, J., Kleesiek, K., . . . Körtke, H. 2009. A randomized controlled trial on the efficacy of carbohydrate-reduced or fat-reduced diets in patients attending a telemedically guided weight loss program. *Cardiovascular Diabetology,* 8**,** 36. Available: DOI 10.1186/1475-2840-8-36.

Gardner, C. D., Kiazand, A., Alhassan, S., Kim, S., Stafford, R. S., Balise, R. R., . . . King, A. C. 2007. Comparison of the Atkins, Zone, Ornish, and LEARN diets for change in weight and related risk factors among overweight premenopausal women: The A to Z weight loss study: A randomized trial. *Journal of the American Medical Association,* 297**,** 969-977. Available: DOI 10.1001/jama.297.9.969.

Gemming, L., Jiang, Y., Swinburn, B., Utter, J. & Mhurchu, C. 2014. Under-reporting remains a key limitation of self-reported dietary intake: analysis of the 2008/09 New Zealand Adult Nutrition Survey. *European Journal of Clinical Nutrition,* 68**,** 259-264.

Glover, M., Kira, A., Gentles, D., Cowie, N., Paton, C. & Moetara, W. 2014a. The WERO group stop smoking competition: main outcomes of a pre- and post-study. *BMC Public Health,* 14**,** 1-10. Available: DOI 10.1186/1471-2458-14-599.

Glover, M., Kira, A., Johnston, V., Walker, N., Thomas, D., Chang, A. B., . . . Brown, N. 2014b. A systematic review of barriers and facilitators to participation in randomized controlled trials by Indigenous people from New Zealand, Australia, Canada and the United States. *Global Health Promotion,* 22**,** 21-31. Available: DOI 10.1177/1757975914528961.

Glover, M., Kira, A., Kira, G., Mcrobbie, H., Breier, B. H., Kruger, R., . . . Funaki-Tahifote, M. 2017. An innovative team-based weightloss competition to reduce cardiovascular and diabetes risk among Māori and Pacific people: rationale and method for the study and its evaluation. *BMC Nutrition,* 3**,** 78. Available: DOI 10.1186/s40795-017-0199-2.

Goldstein, D. J. 1992. Beneficial health effects of modest weight loss. *International journal of obesity and related metabolic disorders: journal of the International Association for the Study of Obesity,* 16**,** 397-415.

Hanson, M. A. & Gluckman, P. D. 2014. Early Developmental Conditioning of Later Health and Disease: Physiology or Pathophysiology? *Physiological Reviews,* 94**,** 1027-1076. Available: DOI 10.1152/physrev.00029.2013.

Hession, M., Rolland, C., Kulkarni, U., Wise, A. & Broom, J. 2009. Systematic review of randomized controlled trials of low-carbohydrate vs. low-fat/low-calorie diets in the management of obesity and its comorbidities. *Obesity reviews,* 10**,** 36-50.

Heymsfield, S. B., Van Mierlo, C. a. J., Van Der Knaap, H. C. M., Heo, M. & Frier, H. I. 2003. Weight management using a meal replacement strategy: meta and pooling analysis from six studies. *International Journal of Obesity & Related Metabolic Disorders,* 27**,** 537.

Huxley, R., Mendis, S., Zheleznyakov, E., Reddy, S. & Chan, J. 2010. Body mass index, waist circumference and waist:hip ratio as predictors of cardiovascular risk--a review of the literature. *European Journal of Clinical Nutrition***,** 16.

Jakubowicz, D., Barnea, M., Wainstein, J. & Froy, O. 2013. High Caloric intake at breakfast vs. dinner differentially influences weight loss of overweight and obese women. *Obesity,* 21**,** 2504-2512. Available: DOI 10.1002/oby.20460.

Johns, D. J., Hartmann-Boyce, J., Jebb, S. A. & Aveyard, P. 2014. Research: Diet or Exercise Interventions vs Combined Behavioral Weight Management Programs: A Systematic Review and Meta-Analysis of Direct Comparisons. *Journal of the Academy of Nutrition and Dietetics,* 114**,** 1557-1568. Available: DOI 10.1016/j.jand.2014.07.005.

Kant, A. K., Andon, M. B., Angelopoulos, T. J. & Rippe, J. M. 2008. Association of breakfast energy density with diet quality and body mass index in American adults: National Health and Nutrition Examination Surveys, 1999–2004. *The*

American Journal of Clinical Nutrition, 88**,** 1396-1404. Available: DOI 10.3945/ajcn.2008.26171.

Kirk, S. F. L., Penney, T. L., Mchugh, T. L. & Sharma, A. M. 2011. Effective weight management practice: a review of the lifestyle intervention evidence. *International Journal Of Obesity,* 36**,** 178. Available: DOI 10.1038/ijo.2011.80.

Klemsdal, T. O., Holme, I., Nerland, H., Pedersen, T. R. & Tonstad, S. 2010. Effects of a low glycemic load diet versus a low-fat diet in subjects with and without the metabolic syndrome. *Nutrition, Metabolism and Cardiovascular Diseases,* 20**,** 195-201. Available: DOI 10.1016/j.numecd.2009.03.010.

Leahey, T. M., Kumar, R., Weinberg, B. M. & Wing, R. R. 2012. Teammates and Social Influence Affect Weight Loss Outcomes in a Team-Based Weight Loss Competition. *Obesity,* 20**,** 1413-1418. Available: DOI 10.1038/oby.2012.18.

Lindström, J., Ilanne-Parikka, P., Peltonen, M., Aunola, S., Eriksson, J. G., Hemiö, K., . . . Tuomilehto, J. 2006. Sustained reduction in the incidence of type 2 diabetes by lifestyle intervention: follow-up of the Finnish Diabetes Prevention Study. *Lancet,* 368 North American Edition**,** 1673-1679.

Loveman, E., Frampton, G., Shepherd, J., Picot, J., Cooper, K., Bryant, J., . . . Clegg, A. 2011. The clinical effectiveness and cost-effectiveness of long-term weight management schemes for adults: a systematic review.

Martins, C., Strømmen, M., Stavne, O. A., Nossum, R., Mårvik, R. & Kulseng, B. 2011. Bariatric Surgery versus Lifestyle Interventions for Morbid Obesity—Changes in Body Weight, Risk Factors and Comorbidities at 1 Year. *Obesity Surgery,* 21**,** 841-849. Available: DOI 10.1007/s11695-010-0131-1.

Mason Durie 2001. *Mauri Ora the dynamics of Maori health,* Singapore, Oxford University press.

McAuley, K. A., Murphy, E., Mclaymsc, R. T., Chisholmphd, A., Storybphed, G., Mann, J. I., . . . Goulding, A. 2003. Implementation of a successful lifestyle intervention program for New Zealand Maori to reduce the risk of type 2 diabetes and cardiovascular disease. *Asia Pacific J Clin Nutr,* 12**,** 423-426.

McCurley, J. L., Gutierrez, A. P. & Gallo, L. C. 2017. Diabetes Prevention in U.S. Hispanic Adults: A Systematic Review of Culturally Tailored Interventions. *American Journal of Preventive Medicine,* 52**,** 519-529. Available: DOI https://doi.org/10.1016/j.amepre.2016.10.028.

McMillan-Price, J., Petocz, P., Atkinson, F., O'neill, K., Samman, S., Steinbeck, K. Brand-Miller, J. 2006. Comparison of 4 diets of varying glycemic load on weight loss and cardiovascular risk reduction in overweight and obese young adults: a randomized controlled trial. *Arch Intern Med,* 166**,** 1466-75. Available: DOI 10.1001/archinte.166.14.1466.

Mendoza, J. A., Drewnowski, A. & Christakis, D. A. 2007. Dietary energy density is associated with obesity and the metabolic syndrome in U.S. adults. American Diabetes Association. Available: http://ezproxy.massey.ac.nz/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=edsgea&AN=edsgcl.162101851&site=eds-live&scope=site.

Ministry of Health 2002. He Korowai Oranga: Maori Health Strategy. Wellington.

Ministry of Health 2012a. A focus on Maori nutrition. Findings from the 2008/09 New Zealand Adult Nutrition Survey. Wellington: Ministry of Health.

Ministry of Health 2012b. A focus on Pacific nutrition. Findings from the 2008/09 New Zealand Adult Nutrition Survey. Wellington, New Zealand: Ministry of Health.

Ministry of Health 2014. Analysis of Household crowding based on Census 2013 data. Wellington New Zealand: Ministry of Health.

Ministry of Health 2015a. Annual update of key results 2014/15: New Zealand Health Survey. Wellington: Ministry of Health. Wellington.

Ministry of Health 2015b. Major casues of death, ranked by age-standardised mortality rates, by gender, Maori and non-Maori, 2010-2012. Wellington. Available: https://www.health.govt.nz/our-work/populations/maori-health/tatau-kahukura-maori-health-statistics/nga-mana-hauora-tutohu-health-status-indicators/major-causes-death.

Ministry of Health 2015c. Tatau Kahukura: Maori Health statistics. Socioeconomic indicators. Wellington: Ministry of Health. Available: https://www.health.govt.nz/our-work/populations/maori-health/tatau-kahukura-maori-health-statistics/nga-awe-o-te-hauora-socioeconomic-determinants-health/socioeconomic-indicators - 1.

Ministry of Health 2016. Anual update of key results 2015/16: New Zealand Health Survey. Wellington.

Ministry of Health 2017. New Zealand Health Survey. Annual data explorer.: Ministry of Health. Available: https://minhealthnz.shinyapps.io/nz-health-survey-2016-17-annual-data-explorer/_w_e927e4c2/ - !/explore-topics.

Ministry of Heath 2017. Clinical Guidelines for Weight Management in New Zealand Adults. Wellington New Zealand: Ministry of Health.

Moore, T. J., Alsabeeh, N., Apovian, C. M., Murphy, M. C., Coffman, G. A., Cullum-Dugan, D., Cabral, H. 2008. Weight, Blood Pressure, and Dietary Benefits After 12 Months of a Web-based Nutrition Education Program (DASH for Health): Longitudinal Observational Study. *J Med Internet Res,* 10**,** e52. Available: DOI 10.2196/jmir.1114.

Mullaney, L., O'higgins, A. C., Cawley, S., Doolan, A., Mccartney, D. & Turner, M. J. 2015. An estimation of periconceptional under-reporting of dietary energy intake. *Journal of Public Health,* 37**,** 728-736. Available: DOI 10.1093/pubmed/fdu086.

National Heart Lung and Blood Institute. 2017. *Classification of Overweight and Obesity by BMI, Waist Circumference, and associated Disease Risks.* Available: https://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmi_dis.htm.

Naude, C. E., Schoonees, A., Senekal, M., Young, T., Garner, P. & Volmink, J. 2014. Low Carbohydrate versus Isoenergetic Balanced Diets for Reducing Weight and Cardiovascular Risk: A Systematic Review and Meta-Analysis. *PLoS ONE,* 9**,** e100652. Available: DOI 10.1371/journal.pone.0100652.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., . . . Gakidou, E. 2014. Articles: Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet,* 384**,** 766-781. Available: DOI 10.1016/S0140-6736(14)60460-8.

Nutbeam, D. 2008. The evolving concept of health literacy. *Social science & medicine,* 67**,** 2072-2078.

Oster, N. V., Welch, V., Schild, L., Gazmararian, J. A., Rask, K. & Spettell, C. 2006. Differences in self-management behaviors and use of preventive services among diabetes management enrollees by race and ethnicity. *Disease Management,* 9**,** 167-175.

Parnell, W., Wilson, N., Thomson, C., Mackay, S. & Stefanogiannis, N. 2011. A Focus on Nutrition: Key Findings of the 2008/09 New Zealand Adult Nutrition Survey. *Ministry of Health: Wellington, New Zealand.*

Pi-Sunyer, F. X. 2005. Weight loss in type 2 diabetic patients. American Diabetes Association. Available: http://ezproxy.massey.ac.nz/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=edsggo&AN=edsgcl.133367452&site=eds-live&scope=site.

Prochaska, J. O., Velicer, W.F. 1997. The Transtheoretical Model of health behaviour change. *American Journal of Health Promotion.,* 12**,** 38-48.

Rennie, K. L., Coward, A. & Jebb, S. A. 2007. Estimating under-reporting of energy intake in dietary surveys using an individualised method. *British Journal of Nutrition,* 97**,** 1169-1176. Available: DOI 10.1017/S0007114507433086.

Sacks , F. M., Bray , G. A., Carey , V. J., Smith , S. R., Ryan , D. H., Anton , S. D., . . . Williamson , D. A. 2009. Comparison of Weight-Loss Diets with Different Compositions of Fat, Protein, and Carbohydrates. *New England Journal of Medicine,* 360**,** 859-873. Available: DOI 10.1056/NEJMoa0804748.

Schulz, P. J. & Nakamoto, K. 2013. Health literacy and patient empowerment in health communication: the importance of separating conjoined twins. *Patient education and counseling,* 90**,** 4-11.

Schwingshackl, L. & Hoffmann, G. 2013. Long-term effects of low-fat diets either low or high in protein on cardiovascular and metabolic risk factors: A systematic review and meta-analysis. *Nutrition Journal,* 12. Available: DOI 10.1186/1475-2891-12-48.

Shai , I., Schwarzfuchs , D., Henkin , Y., Shahar , D. R., Witkow , S., Greenberg , I., . . . Stampfer , M. J. 2008. Weight Loss with a Low-Carbohydrate, Mediterranean, or Low-Fat Diet. *New England Journal of Medicine,* 359**,** 229-241. Available: DOI 10.1056/NEJMoa0708681.

Sharma, A. M. & Padwal, R. 2010. Obesity is a sign - Over-eating is a symptom: An aetiological framework for the assessment and management of obesity. *Obesity Reviews,* 11**,** 362-370. Available: DOI 10.1111/j.1467-789X.2009.00689.x.

Simmons, D., Fleming, C., Voyle, J., Fou, F., Feo, S. & Gatland, B. 1998. A pilot urban church-based program to reduce risk factors for diabetes among Western Samoans in New Zealand. *Diabetic Medicine,* 15**,** 136-142. Available: DOI 10.1002/(SICI)1096-9136(199802)15:2<136::AID-DIA530>3.0.CO;2-P.

Simmons, D., Rush, E. & Crook, N. 2008. Development and piloting of a community health worker-based intervention for the prevention of diabetes among New Zealand Maori in Te Wai o Rona: Diabetes Prevention Strategy. *Public Health Nutrition,* 11**,** 1318-1325. Available: DOI 10.1017/S1368980008002711.

Sjöström, L., Lindroos, A.-K., Peltonen, M., Torgerson, J., Bouchard, C., Carlsson, B., . . . Wedel, H. 2004. Lifestyle, Diabetes, and Cardiovascular Risk Factors 10 Years after Bariatric Surgery. *New England Journal of Medicine,* 351**,** 2683-2693. Available: DOI 10.1056/NEJMoa035622.

Spiegelman, B. M. & Flier, J. S. 2001. Obesity and the regulation of energy balance. *Cell***,** 531.

Sugimoto, M., Asakura, K., Masayasu, S. & Sasaki, S. 2016. Relationship of nutrition knowledge and self-reported dietary behaviors with urinary excretion of sodium and potassium: comparison between dietitians and nondietitians. *Nutrition Research,* 36**,** 440-451. Available: DOI http://dx.doi.org/10.1016/j.nutres.2015.12.012.

Swinburn, B. A., Carey, D., Hills, A. P., Hooper, M., Marks, S., Strauss, B. J., . . . Caterson, I. D. 2005. Effect of orlistat on cardiovascular disease risk in obese adults. *Diabetes, Obesity and Metabolism,* 7**,** 254-262. Available: DOI 10.1111/j.1463-1326.2004.00467.x.

Swinburn, B. A., Sacks, G., Hall, K. D., Mcpherson, K., Finegood, D. T., Moodie, M. L. & Gortmaker, S. L. 2011. The global obesity pandemic: shaped by global drivers and local environments. *The Lancet,* 378**,** 804-814. Available: DOI https://doi.org/10.1016/S0140-6736(11)60813-1.

The Gdb Obesity Collaborators 2017. Health effects of overweight and obesity in 195 countries over 25 years. *The New England Journal of Medicine***,** 13.

The Look Ahead Research Group 2006. The Look AHEAD Study: A Description of the Lifestyle Intervention and the Evidence Supporting It. *Obesity (Silver Spring, Md.),* 14**,** 737-752. Available: DOI 10.1038/oby.2006.84.

Tu'itahi, S. 2007. Fonua, a Pacific model. Hauroa newsletter: Hauora.

Van Gaal, L. F., Mertens, I. L. & Ballaux, D. 2005. What is the relationship between risk factor reduction and degree of weight loss? *European Heart Journal Supplements,* 7**,** L21-L26.

Vidgen, H. A. & Gallegos, D. 2011. What is food literacy and does it influence what we eat: a study of Australian food experts.

Vidgen, H. A. & Gallegos, D. 2014. Defining food literacy and its components. *Appetite,* 76**,** 50-59. Available: DOI http://dx.doi.org/10.1016/j.appet.2014.01.010.

Wadden , T. A., Berkowitz , R. I., Womble , L. G., Sarwer , D. B., Phelan , S., Cato , R. K., . . . Stunkard , A. J. 2005. Randomized Trial of Lifestyle Modification and Pharmacotherapy for Obesity. *New England Journal of Medicine,* 353**,** 2111-2120. Available: DOI 10.1056/NEJMoa050156.

Wadden, T. A., Volger, S., Sarwer, D. B., Vetter, M. L., Tsai, A. G., Berkowitz, R. I., . . . Moore, R. H. 2011. A Two-Year Randomized Trial of Obesity Treatment in Primary Care Practice. *New England Journal of Medicine,* 365**,** 1969-1979. Available: DOI 10.1056/NEJMoa1109220.

Wing, R. R., Lang, W., Wadden, T. A., Safford, M., Knowler, W. C., Bertoni, A. G., . . . Wagenknecht, L. 2011. Benefits of Modest Weight Loss in Improving Cardiovascular Risk Factors in Overweight and Obese Individuals With Type 2 Diabetes. *Diabetes Care,* 34**,** 1481.

Wing, R. R. & Phelan, S. 2005. Long-term weight loss maintenance. *The American Journal of Clinical Nutrition,* 82**,** 222S-225S.

Womble, L. G., Wadden, T. A., Mcguckin, B. G., Sargent, S. L., Rothman, R. A. & Krauthamer-Ewing, E. S. 2004. A Randomized Controlled Trial of a Commercial Internet Weight Loss Program. *Obesity Research,* 12**,** 1011-1018. Available: DOI 10.1038/oby.2004.124.

World Cancer Research Fund & Research, A. I. F. C. 2007. *Food, nutrition, physical activity, and the prevention of cancer: a global perspective*, Amer Inst for Cancer Research.

World Health Organisation 2000. Obesity: preventing and managing the global epidemic. WHO technical report series No. 894 (0512-3054). Geneva: World Health Organisation.

World Health Organization. 2003. *Diet, nutrition and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation.* Geneva.

Wu, T., Gao, X., Chen, M. & Van Dam, R. M. 2009. Long-term effectiveness of diet-plus-exercise interventions vs. diet-only interventions for weight loss: a meta-analysis. *Obesity Reviews,* 10**,** 313-323. Available: DOI 10.1111/j.1467-789X.2008.00547.x.

Wyatt, H. R., Grunwald, G. K., Mosca, C. L., Klem, M. L., Wing, R. R. & Hill, J. O. 2002. Long-Term Weight Loss and Breakfast in Subjects in the National Weight Control Registry. *Obesity Research,* 10**,** 78-82. Available: DOI 10.1038/oby.2002.13.

Wycherley, T. P., Brinkworth, G. D., Clifton, P. M. & Noakes, M. 2012a. Comparison of the effects of 52 weeks weight loss with either a high-protein or high-carbohydrate diet on body composition and cardiometabolic risk factors in overweight and obese males. *Nutrition and Diabetes,* 2**,** e40.

Wycherley, T. P., Moran, L. J., Clifton, P. M., Noakes, M. & Brinkworth, G. D. 2012b. Effects of energy-restricted high-protein, low-fat compared with standard-protein, low-fat diets: a meta-analysis of randomized controlled trials. *The American journal of clinical nutrition***,** ajcn. 044321.

Chapter 3.0 Study manuscript

Evaluating a nutrition education component of the Ka Mau Te WEHI program.

Greer Gibson, BSc Hunt; Rozanne Kruger, PhD, NZRD; Marewa Glover PhD, Bernard Breier, PhD.

College of Health, Massey University, Auckland, New Zealand

3.1 Abstract

Background: New Zealand has high rates (32%) of obesity amongst the adult population; Māori (50.2%) and Pacific (68.7%) populations are most affected. Lifestyle interventions are effective in achieving weight loss, but are often expensive, whilst group and online lifestyle interventions are more cost effective.

Objectives: To develop and assess a component of the nutrition education content for the Internet team-based, incentivised behaviour change Ka Mau Te WEHI weight loss intervention for Māori and Pacific adults BMI ≥30 kg/m^2 at risk of or with T2DM and/or cardiovascular disease.

Methods: Three Internet team-based competitions were conducted in New Zealand's North Island, with seven teams of up to seven participants (n=146) per region. The nutrition education was developed to address key eating behaviours associated with increased risk of weight gain and improve nutrition literacy. The education delivered through daily tips on the website and weekly challenges. Eating behaviours and nutrition literacy were assessed at baseline and six-months.

Results: Although 143 participants started the program; only 41.1% (n=60) completed it. Key eating behaviours changed; 18.3% decrease in drinking one or more sugar sweetened beverages/day, mean days eating fast food decreased by -1.7±2 days (*p<0.001)*; mean days eating fruit +1±1.8 (*p<0.001*) and vegetables +0.8±2 (*p=0.006*) increased significantly. Weight loss was not significant at six months [4.5±17.3kg (*p*=0.115)].

Conclusion: Although this program was attractive to the target population, a high dropout rate was evident and clinically significant weight loss was not achieved. Despite this, the innovative approach used for nutrition education led to significant dietary behaviour changes. Further research to improve retention and build on eating behaviour changes achieved in this at-risk population is warranted.

Key words: Māori, Pacific Islanders, weight loss, lifestyle intervention, obese.

3.2 Introduction

Obesity, the accumulation of excess adipose tissue, is a growing concern in New Zealand. New Zealand has some of the highest obesity rates worldwide with 32.2% of the adult population obese (BMI>30 kg/m^2) and a further 34.4% overweight (BMI 25-29.9 kg/m^2) (Ministry of Health, 2017). Higher rates of obesity are seen in the Māori (50.2%) and Pacific (68.7%) (Ministry of Health, 2017). Obesity is associated with increased risk of chronic disease, including Type 2 Diabetes mellitus (T2DM), cardiovascular disease (CVD) and some cancers (The GDB obesity collaborators, 2017, Poirier *et al.*, 2006). This is associated with increased health cost and economic burden (Lal *et al.*, 2012).

The aetiology of obesity is multifactorial and individual. Factors associated with weight gain are; eating behaviour, sedentary lifestyle SES and genetics (Everson *et al.*, 2002, The GDB obesity collaborators, 2017). Specific eating behaviours that increase the risk of weight gain are; high intake of energy dense foods, sugar sweetened drinks and foods, meals prepared outside of the home, large portion sizes, alcohol and disinhibited eating patterns (World Cancer Research Fund and Research, 2007, World Health Organization, 2003). Māori and Pacific adults have been shown to be more likely to show eating behaviours consistent with increased risk of weight gain than non-Māori or Pacific adults (Parnell *et al.*, 2011, Ministry of Health, 2012a, Ministry of Health, 2012b).

In response the increasing rates of obesity worldwide the World Health Organisation has called for a focus of nutrition and physical activity, as these lifestyle factors have been strongly associated with weight gain (World Health Organization, 2003). For weight loss rather than weight gain prevention there are several effective approaches, lifestyle interventions, weight loss medications and weight loss surgeries (Wadden *et al.*, 2005, Sjöström *et al.*, 2004, Wing *et al.*, 2011). Lifestyle interventions are the first line approach for weight loss; particularly those combining dietary and physical activity components have been found to be more successful than either strategy individually (Wing *et al.*, 2011, Kirk *et al.*, 2011). Intensive lifestyle interventions with individualised support and behavioural counselling have been the most effective (Wing *et al.*, 2011). However,

intensive interventions are expensive and other means of lifestyle intervention such as internet based interventions have been explored, showing promising results (Bowes *et al.*, 2017, Ackermann *et al.*, 2006). However, Internet based interventions experience high attrition rates, which negatively impacts weight loss outcomes (Moore *et al.*, 2008, Womble *et al.*, 2004).

Many dietary approaches to achieve weight loss both within lifestyle interventions and individually have been explored. Overall, dietary interventions irrelevant of the specific manipulation that achieve a calorie deficit successfully, achieve weight loss (Wycherley *et al.*, 2012, McMillan-Price *et al.*, 2006). Dietary interventions that achieve compliance and can be maintained are more successful (Wycherley *et al.*, 2012, Frisch *et al.*, 2009).

There is a dearth in the literature regarding lifestyle interventions for Māori and Pacific Islanders in New Zealand. Of the available studies, modest weight loss, behaviour change and diabetes prevention has been achieved (McAuley *et al.*, 2003, Coppell *et al.*, 2009, Simmons *et al.*, 2008).

Therefore, the aim of this sub-study is to develop and assess a component of the nutrition education content for the Internet team-based, incentivised behaviour change Ka Mau Te WEHI weight loss intervention in Māori and Pacific Island adults.

3.3 Methods

The Ka Mau Te WEHI study is an innovative Internet team-based incentivised weight-loss and lifestyle competition for obese Māori and Pacific adults BMI ≥30 kg/m^2, at risk of T2DM and/or CVD in three regions of New Zealand's North Island. This sub-study evaluates selected nutrition education components of the Ka Mau Te WEHI program. The methods of the Ka Mau Te WEHI study have been described previously (Glover et al, 2017).

Inclusion criteria

Māori or Pacific Island adults, 16 years or older. A BMI ≥30 kg/m^2, at risk of CVD (elevated cholesterol in a blood test within the previous six months) and/or at risk or T2DM (glycated haemoglobin (HbA1c) 41-49mmol/mol), or who had been diagnosed with CVD or T2DM (HbA1c >50mmol/mol). Participants had to be willing to commit to the six-month intervention and a follow up at 12 months, and needed to be willing to visit their doctor to complete HbA1c and cholesterol blood tests. The exclusion criteria included women planning a pregnancy within the next six months, having had a recent pregnancy within the last six months, or who were breast-feeding. People diagnosed with type 1 Diabetes Mellitus, and people who smoked tobacco or marijuana or who used nicotine replacement products from any source, were also excluded.

The further inclusion criteria for this sub-study included participants who met the criteria for the overall study, and had additionally completed both baseline and six-month questionnaires and measurements.

Participants were recruited in teams of seven, there were up to seven teams in each of the three regions. Recruitment was conducted by the regional coordinators, through advertisement, presentations and word of mouth in each community.

The Ka Mau Te WEHI program

The program consisted of a six-month (24 weeks) competition with a follow-up six months later at 48 weeks. There were three eight-week competition phases in each region requiring anthropometric measurements to be repeated, at the end of two-months, four-months and six-months. At the end of each phase a team in each region won a monetary prize, to be donated to a charity of their choosing. The competition was assessed on combined team weight and waist circumference loss and lifestyle behaviours. The lifestyle behaviours were scored on completion of daily and weekly challenges.

Each region had a regional coordinator who worked in a local primary healthcare organization (or similar) in the target community.

The WEHI webpage was the main source of information/education. Lifestyle tips were posted each day; these were mainly written by the principal investigator of the WEHI

program. For the purposes of the sub-study, the researcher wrote daily tips appropriate for the topics under investigation.

Each participant was given a program diary with the nine daily challenges in it; five of these challenges were nutrition-related. The nutrition related daily challenges encouraged exclusion of sugar sweetened beverages, sugar sweetened foods and fast and fried food; they encouraged the consumption of water before each meal, 3^{+} servings of vegetables/day and healthy plate model main meals.

Daily tips

The daily tips for this sub-study were designed to match current Ministry of Health Eating and Activity Guidelines for New Zealand adults and the Eating for a Healthy Heart from the Heart foundation (Ministry of Health, 2015, Heart foundation, 2013). The daily tips aimed to assist the participants in achieving maintainable behaviour-changes, increase knowledge on nutrition, motivation and assist in weight loss. The daily tips also provided information barriers that the participants would face in this program.

The topics of the daily tips provided by this sub-study are shown in **Table 6**:

Table 6. Daily tip topics and the relevant Ministry of Health guidelines.

Ministry of health eating and activity guidelines	Daily tips
Choose and prepare foods:	
That are low in salt	Sodium facts
	Sauces and alternative favouring ideas
	Label reading
With little or no added sugar	Sugar content in drinks
	Keeping sweet treats as treats
	Label reading
	Sauces and alternative favouring ideas
With unsaturated fats instead of saturated fats	Good and bad fats
	Healthy Christmas barbeque recipes
That are mostly whole and less processed	What's all the fuss about fibre
	How to have regular toilet habits
Eat a variety of foods each day	Complete meals
Eat some, legumes, nuts, seeds, fish, poultry and/or red meat	Protein, what you need
	Eating well at barbeques
Eat plenty of fruit and vegetables	Festive summer salads
	Eating well at barbeques
	Complete meals
Limit processed meat and red meat	Eating well at barbeques
Keep intake low of alcohol	Safe alcohol consumption
make water your first choice of drinks	Sugar content of drinks
	How to have regular toilet habits
	Eating on the road
Achieve and maintain a healthy body size	Portion sizes
	Weight loss plateaus
Additional education topics	
Mindful eating	
Breakfast meal ideas	
How to get back on track after the holidays	
How to look after yourself over Christmas	
The meaning of food energy	
Healthy and filling lunch ideas	
Finding the time to be healthy	

Weekly challenges

The nutrition-related weekly challenges were designed to aid each participant's progress in weight loss and food literacy. The weekly challenges provided by the sub-study are shown in **figure 2**:

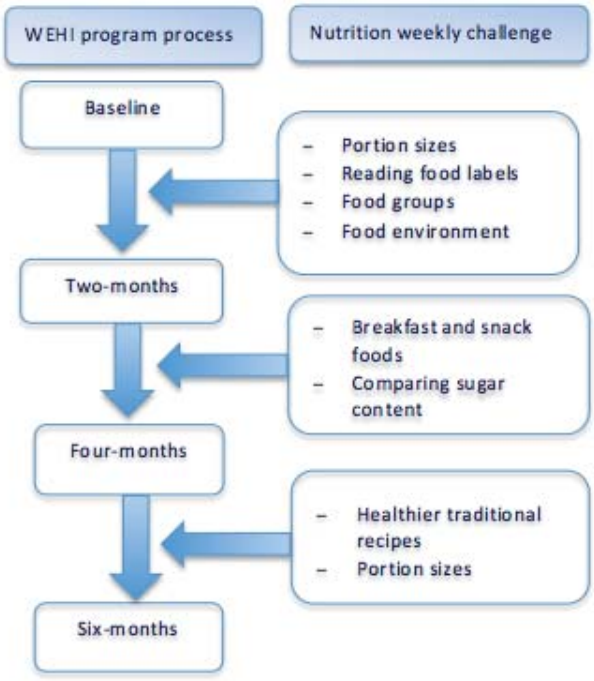


Figure 2. Food and nutrition weekly challenges

Ethics

All participants received anonymised identification codes, which were used to enter results for all information. All participants received an information sheet (appendix C) explaining the study, and completed and submitted a written consent form (appendix C). Participants were offered the transcript of the focus groups if they wanted to review it.

This study was conducted according to the declaration of Helsinki guidelines for interventions. All activities involving human subjects/patients were approved by Northern B Health and disability ethics committee (16/NTB/101).

Study setting

In the three separate competition areas Northland, Manawatu and South Auckland, one competition consisting of up to seven teams was conducted. The areas were chosen due to high population density of either Māori or Pacific Island individuals.

Data collection and management

Research tools

The information used to meet the objectives of this sub-study are shown in **Table 7**:

Table 7. Information used to meet the proposed outcomes of the sub study.

Outcome topic	Information source
Eating behaviour	Baseline and six-month questionnaire Daily challenges Weekly challenges Focus groups
Food literacy	Baseline and six month questionnaire Weekly challenges
Anthropometric measurements	Baseline, two-month and six-month

Participants completed lifestyle questionnaires at baseline and six-months, challenges through the intervention and the focus groups after the six month intervention.

Questionnaires

The questionnaire included 55 questions to assess demographics, eating behaviour, cooking behaviour, food literacy, alcohol use, stress and sleep, perception of weight, food security and exercise behaviours of each participant. The baseline questionnaire can be seen in Appendix C. The nutrition related aspects of the questionnaire included questions from the New Zealand ANS (University of Otago and Ministry of Health, 2011b) and was adapted to reduce participant burden. Adaptions were also made to increase relevance to the New Zealand Māori and Pacific population. The questionnaires were completed individually; regional coordinators were present and available to assist with questionnaire completion.

Weekly challenges

The weekly challenges that were designed to assess knowledge or behaviour included team and individual challenges. Each team received a score for how many team members completed each weekly challenge; the accuracy of answers did not affect the competition points.

Anthropometrical measurements

Research assistants measured height at baseline and weight and waist circumference at baseline and six months. The mean of three measurements was used as the final recorded measure. The same type and brand of measuring tapes and scales were used at baseline and six-months. The teams themselves recorded two-month and four-month weights on the same set of scales with the same instructions.

Focus group

The two focus groups were conducted in the South Auckland region (n=7 participants), following the completion of the six-month intervention and before the 12-month follow up. The aim of the focus group was to understand how the participants perceived the delivery of this intervention and included discussion on enablers, barriers and behaviour changes they did or did not make. The focus groups were conducted by two members of the Ka Mau Te WEHI research team. There was a structured schedule developed for the focus group with pre-planned prompts. The sessions were conducted in familiar locations to the participants and were recorded by two devices. The sessions lasted for approximately two hours each and were concluded with a shared meal provided by WEHI.

Data handling and analysis

The questionnaires and weekly challenge results were entered into excel, double coded and spot-checked for accuracy. Missing data was coded consistently throughout all data sheets and excluded from analysis. The first answer was coded for multiple responses. From the questionnaire a food-ranking question was excluded due the majority of participants misunderstanding the question.

Breakfast foods reported by the participants in the questionnaires were coded into 17 key food groups (appendix A) and further into macronutrient groups and combination of groups as appropriate for breakfast meals. Complete meals were coded for breakfast meals that included a carbohydrate, fruit/vegetable and a protein source.

Questions on frequency of intake or were analysed as means for scale data and frequency and percentage for categorical data.

Data for all nutrition related aspects were further coded into groups that were comparable to the Ministry of Health eating and activity guidelines and the Heart Foundation Eating for a healthy heart guideline for health professionals (Ministry of Health, 2015, Heart foundation, 2013). Percentage of participants meeting the Heart Foundation and MoH guidelines was calculated at baseline and six months.

Knowledge related questions from both the weekly challenges and the questionnaire were coded into correct and incorrect categories.

Anthropometric results were compared at baseline between completers and non-completers. Additionally, change from baseline to six months for al completers and for men and women.

IBM SPSS statistics package version 24 (IBM corporation, New York, USA) was used and Microsoft 2010 excel was used for statistical analysis. Continuous data were tested for normality using the Kolmogorov-Smirnov and Shapiro Wilk test. Non-normally distributed data were log transformed, retested for normality and reported as a geometric mean ± SD. If log transformed data were not normally distributed it was reported as median (25^{th}, 75^{th} percentile).

Within group comparison between baseline and six months periods were conducted using paired two tailed t-tests and comparisons between groups were conducted using two tailed independent t-tests. For non-normally distributed data between-group analysis was conducted using independent sample Mann-Whitney U tests. For within-group comparison of non-normally distributed data Wilcoxon signed-rank tests were used. Statistical significance was determined at $P<0.05$. Categorical data was reported as frequency and percentage.

The focus groups were analysed using qualitative analysis. The key themes of the focus group were website usage, motivators to participate in the program, motivators within the program, the impact of the team-based competition, barriers to participation, challenging aspects of the program, helpful aspects of the program, behaviour change and feedback. Qualitative research is designed to form theories (Sandelowski, 2010). Therefore a degree of interpretation was conducted in the presentation of the results.

The answers for each key theme were grouped, and key themes of the answers were reported with quotes.

3.4 Results

Study population

For this program, 182 participants were recruited and screened, with 143 starting the program. Forty- seven participants came from Northland, 49 from Manawatu and 47 from South Auckland. **Figure 3:** shows an overview of participant completion of the competition.

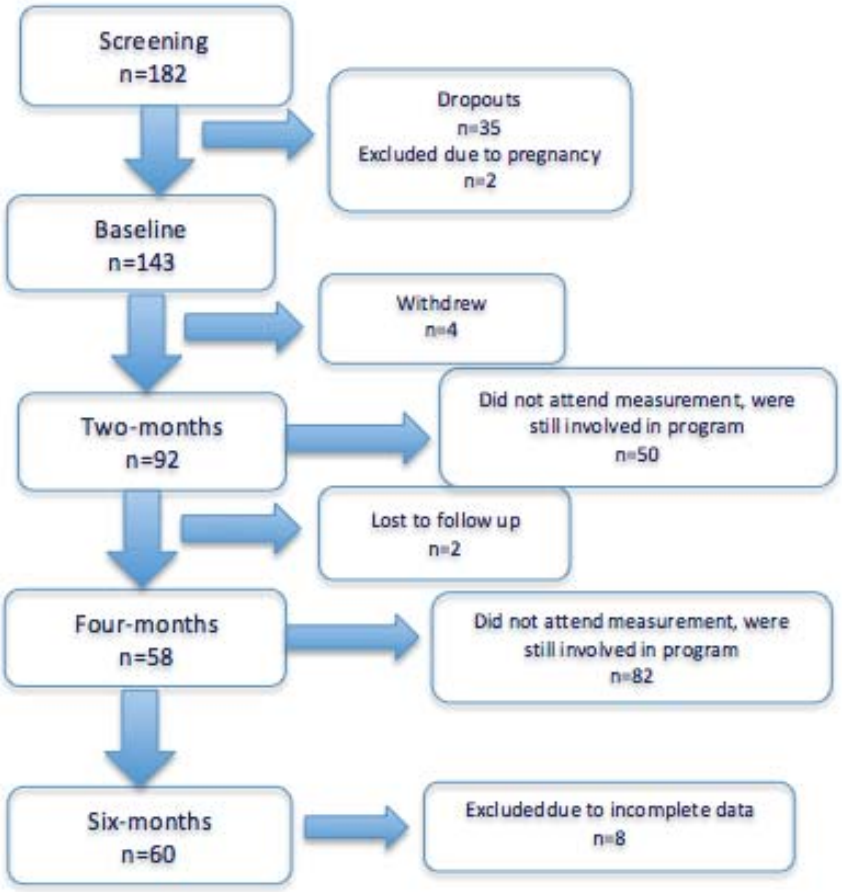


Figure 3. Participant flow chart

Only 60 participants met the inclusion criteria for this sub-study investigating the food and nutrition related aspects. Baseline participant demographics are described in **Table 8:**

Table 8. Baseline participant demographics

	Completers[$](n=60)				Non-completers (n=83)				Difference Completers vs non-completers	
	Men (n=11)		Women (n=49)		Men (n=16)		Women (n=67)		Men	Women
		Max, min		Max, min		Max, min		Max, min		
Age (years)	53 (42, 58)[#]	65, 31	48 (40.9, 48.5)[#]	65, 17	41 (27.2, 52.5)	54, 25	46(39,52)	66, 19	0.03*	0.769
Weight (kg)	132±2^	176, 107	109±1.2^	156, 73	124.7±1^	172, 92	107±1.2^	172, 81	0.282	0.529
BMI (kg/m^2)	44±8[¥]	59, 34	41±7[¥]	58, 31	41±5.6[¥]	52, 31	40±5.6[¥]	53, 30	0.201	0.527
WC (cm)	132±15[¥]	163, 110	116±13[¥]	150, 95	127±14[¥]	145, 102	115±13[¥]	164, 92	0.398	0.711
Highest qualification	n (%)		n (%)		n (%)		n (%)			
School certificate Level 1	0(0.0)		3(6.1)		1(6.3)		8(11.3)			
Level 2 or higher	0(0.0)		12(24.5)		4(25.0)		16(23.8)			
Trade/tech certificate	1(9.1)		3(6.1)		3(18.8)		1(1.5)			
Diploma	4(36.4)		10(20.4)		4(23.5)		9(13.4)			
Tertiary	2(18.2)		14(28.6)		1(6.3)		22(32.8)			
None	3(27.3)		6(12.2)		3(18.8)		3(4.5)			
Other	1(9.1)		1(2.0)		0(0.0)		9(13.4)			

BMI: Body mass index
WC: Waist circumference

*Statistically significant difference *P* =<0.05

^Geometric mean±SD, compared using independent t-test

[#]Median (25, 75percentile), compared using Man Whitney test.

[¥]Mean±SD, compared using independent t-test

[$]Completers –participants with both baseline and six-month anthropometry and questionnaire

None of the demographic parameters were significantly different between completers and non-completers of the study, except for gender. Although the proportion of males and females were the same in the two groups, the males who completed the program were significantly older (p=0.03).

Nutrition education content provided

Nutrition education was delivered in two forms; the daily tips and the weekly challenges. The daily tips were not assessed. Nutrition related daily tips included, but were not restricted to the following topics: sugar content of beverages, how to reduce sodium intake, healthy alternatives to meals and mindful eating .Weekly challenges were either individual or completed as a team. **Table 9:** shows the topics of the nutrition-related weekly challenges in the order that they were completed, and completion numbers.

Table 9. Weekly challenge topics and completion over time

			n=146	
	Topic	**Challenge**	**Recorded***	**Evidence submitted#**
1	Eating behaviour	Meal portion sizes	79	74
2	Food literacy	Reading food labels	77	80
3	Food literacy	Food groups	80	69
4	Food literacy	Food environment –comparing healthy food outlets to unhealthy outlets near work or home	46	31
5	Food literacy	Healthy version of traditional recipe	36	41
6	Eating behaviour	What are you having for breakfast and snacks	62	47
7	Food literacy	Weighing out portion sizes	15	6
8	Eating behaviour	Meal portion sizes	16	8

*Recorded on team webpage #Challenge sheets received by sub-study

Challenges four, five, six and seven were nutrition education content to contribute towards nutrition literacy. Challenges one, two, three and eight were challenges both for education and assessment. Completion of weekly challenges reduced considerably over the duration of the program with challenges from only 5.0% of participants received for challenge eight.

Food literacy as assessed by questionnaire and weekly challenges

Understanding of food and food groups

Participant understanding of food and food groups was assessed from both the questionnaires and the weekly challenges. Understanding of energy density of food increased from baseline to six months. There was a 13.0% (n=8) increase in part being aware that chocolate ice cream is an energy dense food as compared to popcorn, strawberries and carrot sticks to 60.0% (n=32). The weekly challenge, "*What type of food is it",* assessed knowledge of food groups, where certain foods needed to be classified into appropriate food groups. The majority of teams were able to correctly classify most of the foods, as shown in **Figure 4:**

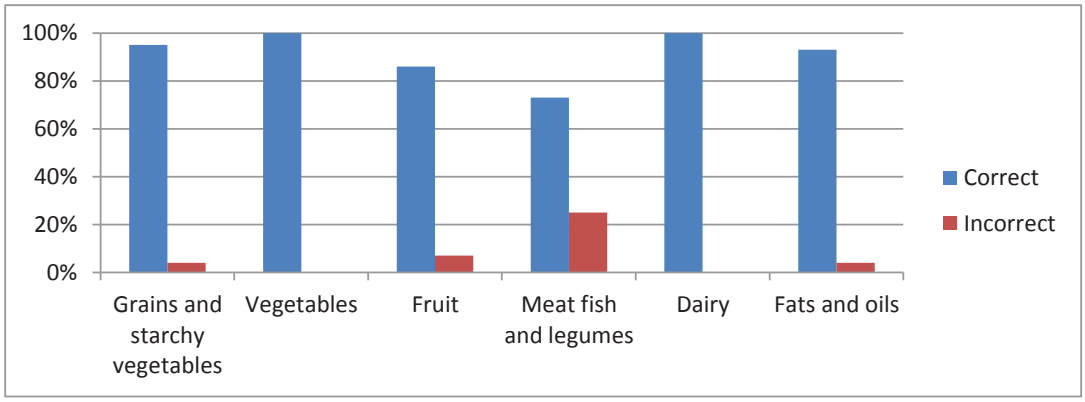


Figure 4. Weekly challenge what type of food is it results

Understanding food labels

The most commonly misclassified group was legumes. Specifically chickpeas and lentils, which were most frequently misclassified as grains. Full results for this challenge are in appendix B. The weekly challenge "Reading food labels", assessed label reading knowledge. **Figure 5:** shows the results of this challenge.

Label reading	n=44	
	Correct	Incorrect
KJ/serve	39(88.6)	5(11.4)
grams/100g	42(95.5)	2(4.5)
Grams sugar/teaspoon	29(65.9)	15(34.1)
Salt in ingredients	43(97.7)	1(2.3)
Comparing foods by per 100g	31(70.5)	13(29.5)

What on the front of food labels can you use to help choose healthier foods	
Heart foundation tick	28(63.6)
Health star rating	7(15.9)
Lite or reduced	5(11.4)
Nutrition information panel	4(9.9)
Free or zero	3(6.8)
Accredited organic	2(4.5)

KJ: kilojoules
g: grams

Figure 5. Weekly challenge, reading food labels

The majority of teams were able to answer four out of five questions correctly. Lack of knowledge was apparent regarding grams of sugar per teaspoon and how to compare products by quantity per 100g. Participants were also asked what on the front of food labels could help them to choose healthier foods. The most common result to this question was the heart foundation tick.

Food preparation

Food preparation knowledge was assessed only in the questionnaires. **Figure 6:** shows individual questionnaire results at baseline and six months for food preparation knowledge.

	n=60	
Question	**Baseline**	**Six months**
	n(%)	**n(%)**
Healthy cooking methods	Correct	Incorrect
Deep fry vs stir fry	54(90.0)	56(93.3)
Shallow fry or roasted	46(76.7)	48(80.0)
Steamed or boiled	55(91.7)	52(86.7)
Grilled or pan fried	50(83.3)	49(81.7)
Healthiest cooking method	41(68.3)	29(48.3)
Unhealthiest cooking method	51(85.0)	47(78.3)
How often do you add salt to food after it has been prepared?		
Never/rarely	26(43.3)	28(46.7)
Sometimes	12(20.0)	19(31.7)
Often/all the time	22(36.7)	11(18.3)
How often do you choose low or reduced fat foods?		
Everyday	5(8.3)	6(10.0)
2-3 times per week	20(33.3)	16(26.7)
1-2 times per months	13(21.7)	24(40.0)
Once per month or less	19(31.7)	9(15.0)
How much butter, margarine or meat fat do you usually add to bread or potatoes		
None	1(1.67)	7(11.6)
One level teaspoon	14(23.3)	20(33.3)
One heaped teaspoon or more	44(73.3)	28(46.6)

Not all percentage will add up to 100% due to missing responses

Figure 6. Knowledge of food preparation at baseline and six months

At baseline the majority of participants correctly identified healthy and unhealthy cooking methods. From baseline to six-months the addition of salt and fats to foods reduced.

Eating behaviour questionnaire

The baseline and six-month questionnaires were used to assess eating behaviour change. The following results are from the completers of the program (n=60), (full results can be found in appendix B).

Beverage consumption

Figure 7: shows change in sugar beverage consumption from baseline to six months.

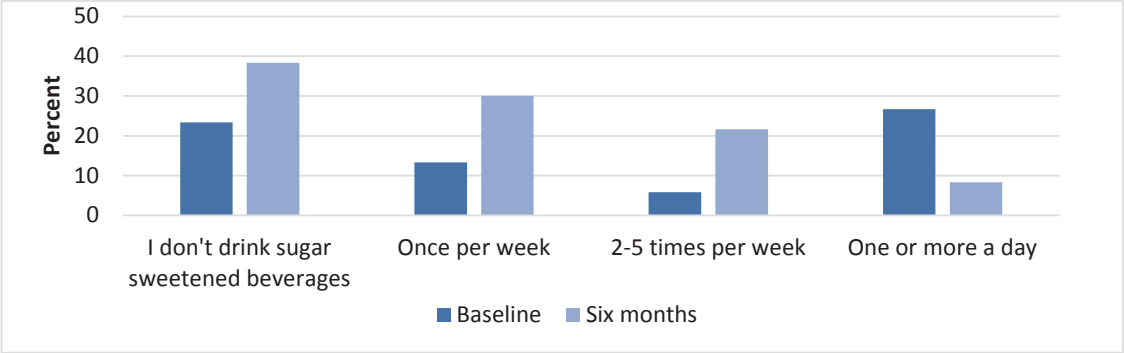


Figure 7. Sugar sweetened beverage consumption baseline to six months

From baseline to six-months there was a 15.0% (n=9) increase in participants who stated they never drink sugar sweetened beverages, and an 18.3% (n=11) decrease in those drinking one or more sugar sweetened beverage per day. At baseline, 28% (n=17) participants did not drink alcohol at all. Of those consuming alcohol (n=43, 71.7%), 58.3% (n=35) did so once a month or less, and 8.3% (n=5) drank alcohol once or more per week. At baseline, the mean (±SD) number of drinks consumed in one drinking day was 5.2±3.9 with no significant change at six months (p≥0.05) (2-tailed paired t-test). Mean daily water consumption increased significantly (*P*=<0.05) at six-months however only 20.0% (n=12) of the participants drank ≥2L/day.

Breakfast eating behaviour

Breakfast eating patterns at baseline and six months are shown in **Figure 8:**

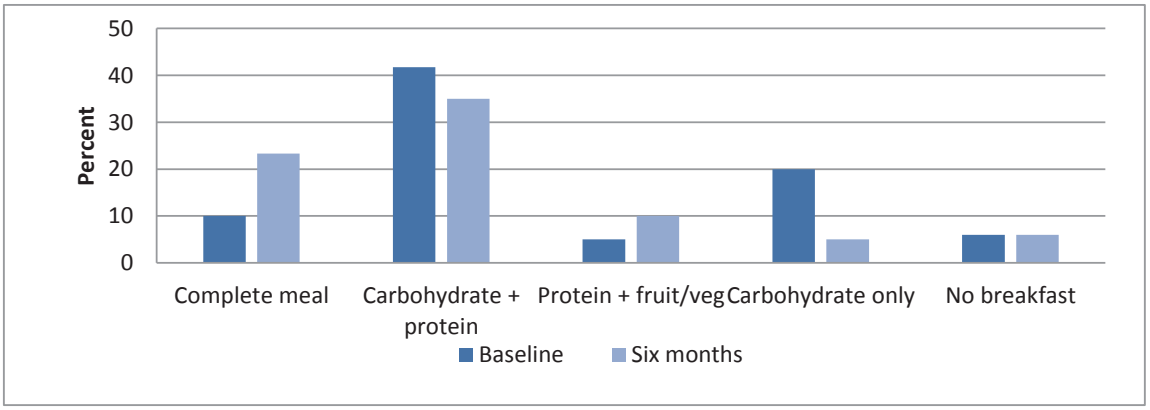


Figure 8. Change in food groups in the breakfast meal at baseline and six months

An increase of 13.3% (n=8) was evident in those who ate a complete meal at breakfast, consisting of a protein, carbohydrate and fruit or vegetable. Those consuming only carbohydrates for breakfast decreased by 15.0% (n=9) at six months. Fruit within the breakfast meal increased from baseline 27.2% (n=14) to 40.4% (n=21) at six months. Legumes, nuts and seeds increased by 7.5% (n=4). Added sugar and fat decreased by 15.1% (n=8).

Table 10: shows the changes in eating behaviour regarding foods from the key food groups from baseline to six-months. The number of days eating fruit, vegetables, legumes and fresh seafood increased significantly (*P*=<0.05), whilst the number of days eating fast food, snack chips and/or crackers and desserts decreased significantly (*P*=<0.05). There was no significant change in the mean number of days eating breakfast. Additionally from baseline to six months there was an 18.3% (n=11) increase in participants choosing ½ a cup of pasta over 1 or 2 cups.

Table 10. Change in eating behaviour from baseline to six months, compared to national guidelines.

N=60										
	Eating behaviour				Proportion of participants meeting the guidelines					
	Baseline[$]	Six months[$]	Mean difference			Baseline[#]	Six months[#]		Baseline[#]	Six months[#]
	Mean±SD			Sig	MOH guidelines	n (%)	n (%)	Heart Foundation guidelines	n (%)	n (%)
Days fruit eaten/week	4.3±2.2	5.6±1.8	1± 1.8	<0.001*	7 days	13(21.7)	24(40.0)	7 days	13(21.7)	24(40.0)
Serving of fruit per day	1.8±1.1	2.9±1.8	0.9±1.5	<0.00*1	≥2 serves	35(58.3)	44(73.7)	3 to 4 serves	12(20.0)	17(28.3)
Days vegetables eaten/week	5±1.6	5.6±1.6	0.8±2	0.006*	7 days	17(28.3)	30(50.0)	7 days	17(28.3)	30(50.0)
Servings of vegetables/day	2.3±1.2	2.9±1.7	0.6±2.4	0.002*	≥3 serves	20(33.3)	30(50.0)	3 to 4 serves	20(33.3)	30(50.0)
In the past seven days										
Fast food meals or snacks?	3±1.8	1.9±1.5	-1.7±2	<0.000*	NA			≤1/week	15(25.0)	27(45.0)
Regular snack chips or crackers	2.3±1.9	1.7±1.7	-0.7±2.5	0.026*	NA			NA		
Dessert or other sweets	3.1±1.8	2±2	-1.1±2.5	0.002*	NA			NA		
Lean meat	2.8±1.9	3.3±1.5	0.6±2	0.039*				1-1.5/day	0(0.0)	1(1.67)
Fresh seafood	1.2±1.2	1.6±1.3	0.4±1.5	0.027*	≥1/day	40(66.7)	50(83.3)	2/week	20(33.3)	28(46.7)
Legumes	0.8±1.4	1.4±1.7	0.6±2	0.039*				4-5/week	1(1.67)	5(8.3)
Breakfast	4.4±2.4	4.6±2.6	0.2±2.6	0.5	7/week	24(40.0)	26(43.3)	7/week	24(40.0)	26(43.3)

$ Mean±SD

*Statistically significant difference *P*=0.05

[#] Frequency (%)

Anthropometric changes

Anthropometric measurements were compared at baseline, two-months and six-months to assess the effectiveness of the lifestyle program. **Table 11:** shows the mean weight change and significance at each time point for all completers.

Table 11. Anthropometry at baseline, two months and six months

	N=60								
	Baseline^	**Two months#**	**Six months**	**Change: Baseline - two months**		**Change: Two months –six months**		**Change: Baseline-six months**	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Sig	Mean±SD	Sig	Mean±SD	Sig
Weight (kg)	115±22.4	106.7±16.9	110.9±21.9	-6.7±21.3	0.046*	-3.7±20.2	0.23	-4.5±17.3	0.115
BMI (kg/m^2)	41.5±7.3	38.7±5.8	40±7.4	-1.9±7	0.084	0.8±6.7	0.42	-0.8±6.4	0.472
WC (cm)	119±14.6	109.6±12.6	113.6±16.4	-8.8±16.2	0.001*	-4.3±16.8	0.11	-0.01±13	0.995

^N=143
#N=92
*Statistical significance at *P*<0.05
WC:Waist circumference
BMI:Body mass index

The only significant reduction in mean weight and waist circumference (*P*<0.05) occurred between baseline and two months. **Table 12:** shows anthropometric changes between baseline and six months for males and females separately.

Table 12. Anthropometric change from baseline to six-months, males and females

	Male			
	Baseline	**Six-month**	**Difference**	***P*-value**
		n=11		
Weight[1]	132±2^	128.3±0.4	-0.08±1	0.072
Waist circumference[1] (cm)	131±15.3~	128.9±15.6~	-2.8±6.8	0.195
BMI[2] (kg/m^2)	42.1(38.8, 53.8)#	41.2(38.4, 51.2)#		0.062
	Female			
		n=49		
Weight[1]	109±1.2^	104.9±1.2^	-0.1±0.2	0.001*
Waist circumference[1] (cm)	116.9±12.8~	110±14.7~	-6.9±9	<0.00*
BMI[2] (kg/m^2)	40(35, 45.1)#	38.2(34, 43.8)#		<0.00*

^Geometric mean±SD
~Mean±SD
#Median (25,75)
*Statistical significance *P*<0.05

[1]Paired samples t-test
[2]Wilcoxon signed rank test
BMI: Body mass index

When separating the results for males and females, it was clear that there was a significant decrease in waist circumference ($p<0.00$), BMI (kg/m^2) ($p<0.00$) and weight ($p=0.001$) from baseline to six months for females. For males there was no significant change in any of the parameters.

Focus groups

Two focus groups were conducted with participants from two different teams in the South Auckland region (n=7). One team was more successful in the competition winning two of the phases as compared to the other team who won none. The key themes and findings are presented below. The full themes can are in Appendix C. Quotes from the focus groups will be presented in italics.

Website usage

Over the course of the program website usage decreased, some participants only looked at the website once or twice over the six-months and others went on less as the program went on.

"yea I went on the website.. once maybe twice"

Motivators to participate in the program

Participant's reasons for starting the program were varied; some participants wanted to lose weight, whilst others wanted to do the program to spend more time together as a family.

Motivators within the program

A key motivator for behaviour change was the competition and the points. The participants were competitive. Their determination to earn points led to participants avoiding situations where they were likely to overeat or loose points by having sweet food or drinks. For example going on holiday and out for dinner.

> *"When I go to other places I dine out or at church where we normally have a lot of food, I am normally mindful that I shouldn't be having that and I'm considerate of the members of the program"*

The WEHI diary was another key motivating factor; participants from both groups stated that it was an important tool to maintain motivation.

"The useful tool was having that book the WEHI book… I think that was quite an encouragement"

"You know what the driving force was, it was that piece of paper that you had to tick every day and if you didn't get a tick then to me that was a fail"

The effect of the program being a team based competition

When asked if they stayed for the whole program the competitive drive was again apparent.

"How else were we going to win?"

Not winning some of the competition phase's had a large impact on many of the teams. The two teams interviewed had different responses to not winning the first phase. For the winning team this provided extra motivation to win the next phase.

"That's when the game face turned on for real, ..I felt like we got ripped off"

For the other team the motivation moved from winning the competition to doing the program for them.

"I think the first three months it was all about you know the group getting that because it was about the prize, for me personally not getting the prize it was a bit discouraging… continuing for the next three months it was more your personal importance"

The participants who won two of the phases stated that they stayed involved for the duration of the program. The team that did not win a phase were not as consistently involved.

Barriers to participation

Participants in the team that did not stay involved for the whole program stated that family and financial stress were barriers to participation. These situations included extended family moving in over the duration of the program and a family situation occured that resulted in debt and significant levels of stress, thereby impacting their outcomes.

"But throughout the journey I had a bit of a relapse based on family issues"

A major challenge identified by both teams was the holiday season, with multiple celebrations and barbeques. Over this time the participants found it more difficult to complete the daily or weekly challenges and to maintain weight loss.

> *"I just kinda dwindled towards December that was a really hectic time"*

One team decided to enjoy the holiday season and not focus on the program.

> *"But you know during that Christmas period it was hard but we made a point of saying ok all things off"*

Challenging aspects of the program

The daily challenges that the participants in both focus groups found the most difficult were sugar-sweetened beverage free days, fast and fried food free days and sweet treat free days. All participants agreed that getting together each week, as a team was difficult. Remembering to look at the daily tips on the website was a common challenge. The reasons mentioned for this were twofold; firstly, the fact that a website had to be accessed to receive nutrition information, and secondly that the tips were not easy to find and access on the website. Participants often requested to have the tips sent to them via email in order to bypass this activity.

Helpful aspects of the program

The WEHI diaries have been mentioned above as a helpful tool. In addition, the daily tips were enjoyed by participants that did visit the website regularly, especially the tips that focused on stress management, portion sizes and sugar content of drinks. Participants also enjoyed the cooking challenges and the food environment challenge.

> *"On the website there was a post that went up that had like sugar intake that was great to see like fruit punch it showed how much sugar was inside that".*

> *"It was an eye opener to see how many fast food joints were just sort of next door"*

Behaviour changes

Mixed results were apparent when exploring the participant's ability to change portion sizes. The winning team members reported that they were successful and ate according to the plate model. However, a member of this team was cooking the majority of the meals and providing them to her team members in set portion sizes.

"So I would make all the meals for all of us so I could make up to ten meals a day and that was ten of lunch and ten of dinner for all of us and trying to keep it healthy"

Conversely, the non-winning team members stated that changing portion sizes was challenging and they were not successful in eating smaller portions. Despite this struggle, these team members were able to identify during the focus group session that they had made multiple lifestyle changes. These changes included having vegetables each day, cutting out sugar sweetened beverages and having vegetables at work meals. Interestingly, prior to the focus group, this team was unaware of the changes that they had made.

"So we've kept with water in my home and all my visitors know that"

"Out of all the things of all the points I really enjoyed eating the vegetables, so there is a vegetable shop across the road and so just instead of buying a pie at lunch… I would have a tin of tuna and make a salad"

Feedback

Common feedback was that an app would have been more user-friendly compared to a website, and that notifications to check the daily tips would be helpful. Further common feedback was the lack of celebration at each phase for both winning teams and non-winning teams. Participants felt they had put a lot of effort in, and felt that this was not recognised.

"I found it hard working the website in terms of I had to remember to jump on the website but everyone had cell phones so if I had an app that gave you an alert you had no choice to check your alert so I felt that would have been a more engaging way".

"..for me well the luxury of time also being part time and having two kids under 5 I found it a really struggle to fill out the forms and then scan and then upload it. I think it would have been much easier if it was an app"

3.5 Discussion

Participant demographics and dropout rates

The large number of participants recruited (n=182), suggests that the Ka Mau Te WEHI program was attractive to the target population and culturally salient by design. This could be attributed to the use of Te Whare Tapa Whā Māori model of health and Fonua a Pacific model of Health that was utilized in the design of this program (Durie, 1994, Tu'itahi, 2007). Culturally tailoring lifestyle interventions also shown to be an effective way to recruit cultural and ethnic minorities globally (McCurley et al., 2017). Fonua has five dimensions, global/environment, community/national, physical/local, mental/family and spiritual/individual health (Tu'itahi, 2007). The consideration of individual health as a whole align between Te Whare tapa Whā and Fonua. The aspects of the two models will be discussed using the aspects of health outlined in Te Whare tapa Whā. Te taha tinana (physical health), was addressed through the encouragement to eat healthy foods, avoid unhealthy foods and to do regular physical activity. Te taha hinegaro (mental health) was addressed through providing the participants with knowledge to empower them to make changes. In regards to te taha whānau (family/social health) a team-based intervention provides social support for the individual and the use of community health workers to recruit and support participants. Health workers have been successfully used for recruitment of specific cultural communities both in New Zealand (Glover *et al.*, 2013) and the United States of America (USA) (Buckley *et al.*, 2015, Gutierrez *et al.*, 2014). Te taha wairua (spiritual health) is much harder to address within a six-month lifestyle intervention. Especially considering the deep-rooted history of colonisation within New Zealand that has resulted in the loss of key cultural practices in regards to the gathering and preparation of kai (food) (Tapera *et al.*, 2017).

Eighty-one percent of the participants that started the program were female and only 19% were male. There have been similar findings in lifestyle interventions within New Zealand and internationally. Two studies within New Zealand recruited 33% and 36% males respectively (Coppell *et al.*, 2009, Simmons *et al.*, 2008). A United Kingdom (UK) and US study only recruited 13% and 32% respectively (Bowes *et al.*, 2017, Diabetes Prevention Program Research Group, 2002).

A large number of participants did not complete six-month measurements and/or questionnaires (58.0%). Therefore, the small number that met the inclusion criteria did not allow for comparison between regions, ethnicities or teams. The dropout/non-completion rate was higher than that of other Internet based lifestyle interventions, which achieved dropout rates of only 10-18% (Bowes *et al.*, 2017, Folta *et al.*, 2009). However, Moore *et al* (2008), found that only 25.9% were still active on the website at 12-months. The two with higher retention rates provided higher levels of individual support. This suggests that to utilise the economical design of an Internet based intervention, further behavioural support may be required.

Main findings

Nutrition education content

The nutrition education topics developed for this sub-study were tailored to the eating behaviours of the target population, provided culturally relevant food examples and addressed challenges that the participants may face. Additionally it was informed by evidence based MoH and Heart Foundation guidelines (Ministry of Health, 2015, Heart foundation, 2013). A variety of different dietary manipulations such as low carbohydrate diets that are not based on national guidelines can also produce significant weight loss (Frisch *et al.*, 2009, Shai *et al.*, 2008). However, mixed nutritional messages that are prevalent in the developed world can result in confusion and doubt of science-based recommendations in the general population (Nagler, 2014, Dodds and Chamberlain, 2017). Therefore, in the interest of participants understanding of key healthy eating behaviours, consistency in nutritional messages developed by this sub-study using national guidelines may have been beneficial.

The key nutritional messages throughout this intervention were to increase fruit, vegetable and beneficial fat intake, to decrease fast food, sweet food, sugar sweetened beverages, and to reduce portion sizes. This is similar to the advice provided in successful lifestyle interventions such as the Diabetes Prevention program and a diabetes prevention lifestyle intervention within New Zealand (The Diabetes Prevention Program Research Group, 2002, McAuley *et al.*, 2002). In contrast to these studies where the

nutrition education was not delivered in person or in individual sessions, therefore uptake and understanding of the education for this sub-study was self-directed.

Nutrition literacy

Several aspects of nutrition literacy were assessed. However, nutrition literacy was not assessed using a validated tool. At baseline most participants correctly answered questions of key nutrition literacy topics, for example identifying healthy and unhealthy cooking methods. Food groups were well understood, with the exception of legumes. Legumes are not a cultural food for these populations, which may explain this result. Label reading was assessed in a weekly challenge; most teams were able to answer 80% correctly. However, the key practice of label reading to compare foods by 100g was commonly not achieved. The concept of energy density was also more challenging. However, there was a 13% improvement in identifying energy dense foods at six months. Label reading was not assessed before and after the intervention. However, the results of both label reading and energy density are comparable to the outcome of a nutrition education study that improved correct results from 55% pre intervention to 70.0% correct post intervention (Hawthorne *et al.*, 2006).

Eating behaviour

The program achieved significant changes in key eating behaviours that are associated with weight gain and disease risk (World Health Organization, 2003).
Servings per day of fruit and vegetables increased by (0.9±1.5, $p<0.001$) and (2.3±1.2, $p=0.002$) respectively. However, by six-months only 50.0% of participants met the MoH guidelines for vegetable intake. Conversely, 73.3% of the participants met the guideline for fruit intake. A recent RCT in USA, found that nutrition education with provision of fruit and vegetables increased fruit consumption. Whilst, education alone did not, and did not significantly increase vegetable consumption either (Honrath *et al.*, 2018). The higher uptake of fruit consumption than vegetables in this study could be related to taste preference and seasonal availability. The increase in both fruit and vegetables in this study could be due to the focus on vegetable consumption in the daily challenges.

Eating occasions of fast food decreased by (-1.7±2, *p<0.001)*. Despite this by six months only 45.0% of participants met the Healthy heart guidelines of once or less per week (Heart Foundation, 2013). In comparison, in the ANS 2008/09 41.7% and 36.7% of Māori and Pacific adults consumed takeaways less than once per week (Ministry of Health, 2012a, Ministry of Health, 2012b). The ANS is based on the entire Māori and Pacific adult population, whilst this study only included Māori and Pacific adults with a BMI of 30 and over in the selected areas. These differences may have resulted in a higher initial consumption rate of takeaway food in this sample. The reduction is still a significant achievement.

At baseline 63.4% of participants were having sugar-sweetened beverages more than once per week. At six-months this decreased to 31.7%. Comparatively in the ANS 2008/09 37.8% and 40.7% of Māori and Pacific adults reported having sugar-sweetened beverages less than once per week (Ministry of Health, 2012a, Ministry of Health, 2012b). Not only did sugar sweetened beverage consumption decrease, it decreased below the intake of the overall New Zealand Māori and Pacific populations. This finding may have been prompted by the specific nutrition education messages and the focus within the daily challenges over the period of the intervention leading to changes in nutrition literacy and behaviour change.

There was no significant change *(p=0.5)* in the mean days eating breakfast from baseline (4.4±2.4) to six months (4.6±2.6). Only 43.3% of participants were eating breakfast every day. This is lower than Māori (48.5%), Pacific (45.2%) and adults overall (60.0%) (Parnell *et al.*, 2011). Skipping breakfast has been associated with increased levels of obesity (Ma *et al.*, 2003, Megson *et al.*, 2017). As this study included only participants classified as obese this may explain the lower rate of daily breakfast consumption apparent from these results. Of interest, there was a greater than 90% compliance rate with recommendations to consume breakfast in the study by (Dhurandhar *et al.*, 2014) in Sweden. Comparatively, the low number of participants eating breakfast at six months in WEHI (43.3%) could be explained by the lack of formal nutrition education on this topic in this study. There were only daily tips provided on this topic and it was not one of the daily challenges.

In comparison to the dietary changes achieved in this sub-study the three-year long Ngati and Healthy diabetes prevention program for rural living Māori conducted by Coppell *et al* (2009) showed an increase in wholegrain consumption in females. However, no other dietary changes were significant including fruit and vegetable intake (*p*>0.05*)* (Coppell *et al.*, 2009). The key eating behaviours discussed here with the exception of breakfast and fruit were the focus of the daily challenges. As there was a significant improvement in these eating behaviours this may suggest that the daily challenges were a key driver in the behaviour changes seen in this sub-study.

Not visiting the website regularly was reported by focus groups participants. As a result, participants may not have read the daily tips that addressed the importance of breakfast consumption. Energy intake was not measured in this sub-study. Nor was it a specific focus in the daily challenges. However, a calorie deficit from energy in versus energy out is important to achieve weight loss (Frisch *et al.*, 2009, Klemsdal *et al.*, 2010, Sacks *et al.*, 2009). The participants may not have prioritised eating behaviours that were not clearly a daily challenges such as eating breakfast and overall energy consumption. It is possible that participants may not have comprehended the importance of breakfast, or how to achieve a calorie deficit for weight loss.

Anthropometry

The overall weight loss at six months was not statistically significant (-4.5±17.3kg, *p=0.115).* When separated by gender the female group had a statistically significant reduction in weight (-0.1±0.2kg, *P=0.001*), waist circumference -6.9±9cm, (*p<0.00*) and BMI (*p<0.00)*. Mean waist circumference for women was still above the cut-off for increased chronic disease risk at six months (110±14.7cm) (Ministry of Health, 2012c). The weight loss achieved in this study was lower than that achieved in other lifestyle interventions worldwide and not clinically significant. At the lower end an Internet only lifestyle weight loss program achieved a -1.9kg (95% CI -2.2, -6.2, *p<0.001)* weight loss at 12 months in obese adults (n=52) (Moore *et al.*, 2008). Comparatively, participants in the intensive lifestyle intervention arm of the DPP achieved a -5.6kg (*p<0.001) (Diabetes*

Prevention Program Research Group, 2002). Within New Zealand culturally tailored lifestyle interventions have had mixed results; three have failed to achieve statistically significant weight loss (Coppell *et al.*, 2009, Simmons *et al.*, 1998, Simmons *et al.*, 2008 (Coppell *et al.*, 2009, Simmons *et al.*, 1998, Simmons *et al.*, 2008). Conversely, a four month diabetes prevention lifestyle intervention for Māori adults (n=36) achieved a significant weight loss of -3.1kg (95% CI -4,-2.1) *(p*<0.001) and waist circumference reduction of -7.0cm (95% CI -9,-5) (*p<0.00)* (McAuley *et al.*, 2003). Similar to the WEHI study 77.8% were female.

In contrast to the WEHI study, the program by McAuley *et al.* (2003) included personalised dietary and exercise programs and support. The low level of individual support in the WEHI program as compared to other more successful lifestyle interventions may in part explain the lack of weight loss achieved in this program (McAuley *et al.*, 2003, Wing *et al.*, 2011).

Participants achieved some significant dietary changes however no significant weight loss was achieved from baseline to six months. Acknowledging the stages of change and providing behavioural interventions have been identified as an important factor in lifestyle interventions (Wadden *et al.*, 2011, Diabetes Prevention Program Research Group, 2002). Additionally, the theory of planned behaviour theorises that individuals must have both the intent and ability in order to perform a behaviour (Ajzen, 2006). In a large RCT that assessed lifestyle intervention outcomes by stages of change those who progressed to the action stage of change were three times more likely to achieve a behaviour change (Johnson *et al.*, 2008). The lack of weight loss achieved may suggest that the participants were either not able or not ready to make sufficient behaviour changes to lose weight. These considerations were further supported in the findings of the program evaluation.

Program evaluation

It was clear that participant's website usage decreased over time, if they used it at all. This finding is in line with other Internet based interventions (Moore *et al.*, 2008,

McConnon *et al.*, 2007, Womble *et al.*, 2004). In a RCT evaluating an internet lifestyle intervention Womble *et al.* (2004) found that those using the website more frequently achieved greater weight loss -2.3±4.3% vs 0.6±3.1% (*P<0.02).* This may have also been a factor in the WEHI program, as it was clear from the program evaluation that participants lost motivation after not winning the first competition phase, and consequently didn't stay involved. In contrast, those winning some of the phases remained involved and continued to strive to win the competition. A further barrier to participation was the Christmas holiday period, as is clear from the high dropout rate.

Motivators to participate

The reason participants joined the program were varied, and were mostly not about achieving weight loss. Some wanted to lose weight and others joined to support family members or merely to win the competition. The more successful teams within the competition were all highly competitive. When asked what kept them going, winning was the overall factor. Weight loss appeared not to be the primary motivating factor for some participants. Therefore these participants may not have had the intent to make the necessary behaviour changes to lose weight (Ajzen, 2006).

Within the program, the WEHI diary was agreed by all focus group participants to be a key-motivating factor. This aligns with the finding that personal monitoring and goal setting is an important factor to successful eating behaviour change in weight loss interventions (Acharya *et al.*, 2011).

Eating behaviour

Uncertainty on what to eat was a key problem area for participants in this study, particularly appropriate food choices and ideas for healthy meals. In contrast, a study by Murphy et al maintained higher participation rates by providing two-weekly group cooking sessions facilitated by dietitians where unfamiliar foods were introduced and desirable eating patterns were discussed. This allowed participants the opportunity to discuss their specific dietary challenges, therefore supporting behaviour change (Murphy *et al.*, 2003).

In this sub-study, one of the team members of a successful team cooked and plated up two meals a day for the majority of their team, thereby taking care of the issues around portion sizing and food choice for the team. This is a clear representation of manaakitanga (to show respect and care for others) which is a culturally appropriate and kind action of this participant. However, the long term implication of this may have negatively impacted the team members as this is not sustainable following the competition. The team members did not change their own behaviour specifically, they were just participating and therefore may not have learnt key dietary behaviours for themselves.

A systematic meta-analysis evaluating effectiveness of partial meal replacements for weight loss, also found that interventions where food was provided initially achieved greater weight loss (Heymsfield *et al.*, 2003). In comparison portion sizes remained a challenge for participants in the other teams that were not as successful in the competition, and did not have the same support regarding meals.
Work place eating behaviour had also been affected through the team competition. One of the teams were colleagues; being in the competition together resulted in changing the composition of team lunches to include salads, and less junk food being offered in the work place. This is in line with findings that changing work place culture is effective in lifestyle interventions aiming to reduce CVD risk and weight gain prevention (Racette *et al.*, 2009, Fernandez *et al.*, 2015).

Overall program feedback

A key area of critique on the competition-based program was that there wasn't enough ceremony and celebration around the changes achieved by participants in this program. Participants wanted even small achievements to be rewarded whereas only one team in each competition at each phase received a prize. Furthermore, a team that did not do so well was unaware of the positive lifestyle changes they had put into practice until it was discussed during the focus group sessions. Recognition of positive changes may have helped them maintain motivation. Empowerment was discussed in the literature review, and in relation to Te Whare Tapa Whā this works on the mental health level (hinengaro) (Nutbeam, 2008, Durie, 1994).

Participants agreed that having the team was important to them and was a motivating factor. An Internet team based weight loss intervention in the USA (Leahey *et al.*, 2012), found that higher social influence in a team was associated with greater weight loss (*p<0.001).* This suggests that team-based design was an important positive factor of the study design.

3.5.7 Strengths and limitations

The strengths of this intervention included the following: the use of Te Whare Tapa Whā in the design, that the nutrition education was targeted to the population group and that the education was delivered in innovative ways including both individual and team-based learning. Peer based learning is beneficial in promoting lifestyle behaviour changes (Leahey *et al.*, 2012).

There were several limitations. The website was not designed to collect individual data on website use and weekly challenge data was not consistently returned to the research team and could not be analysed. Due to lack of individual data we could not identify if participants were completing challenges at the end of the intervention, and therefore participants who were not actively involved in the program at 6-months may have been included in the analysis as completers. Food literacy was not assessed using a validated tool, but only through weekly challenges. Therefore, the accuracy and applicability of the information gathered cannot be determined. This sub-study was completed soon after the 12-month mark. Therefore, 12-month results and participant feedback on the nutrition related daily tips and nutrition weekly challenges and ethnicity information was not available. Finally, the nutrition education for the WEHI study was written by multiple researchers and therefore was not all based on or in line with the recommendations from the sources stated in the methods of the sub-study.

3.6 Conclusion

This program was attractive to the target population, used an innovative approach for nutrition education and achieved significant changes in key dietary behaviours. However, no clinically significant weight loss was achieved and the study experienced a high

dropout rate. Further, research to improve retention and improve anthropometrical outcomes in this at risk population is warranted. Key development areas are the usability of the technology and building on eating behaviour changes to achieve a greater calorie deficit.

References

Acharya, S. D., Elci, O. U., Sereika, S. M., Styn, M. A. & Burke, L. E. 2011. Using a Personal Digital Assistant for Self-Monitoring Influences Diet Quality in Comparison to a Standard Paper Record among Overweight/Obese Adults. *Journal of the American Dietetic Association,* 111**,** 583-588. Available: DOI https://doi.org/10.1016/j.jada.2011.01.009.

Ackermann, R. T., Marrero, D. G., Hicks, K. A., Hoerger, T. J., Sorensen, S., Zhang, P. Herman, W. H. 2006. An Evaluation of Cost Sharing to Finance a Diet and Physical Activity Intervention to Prevent Diabetes. *Diabetes Care,* 29**,** 1237.

Ajzen, I. 2006. Behavioral interventions based on the theory of planned behavior: Brief description of the theory of planned behavior.

Bowes, A., Begley, J. & Kerr, D. 2017. Lifestyle change reduces cardiometabolic risk factors and glucagon‐like peptide‐1 levels in obese first‐degree relatives of people with diabetes. *Journal of Human Nutrition and Dietetics,* 30**,** 490-498. Available: DOI 10.1111/jhn.12440.

Buckley, J., Yekta, S., Joseph, V., Johnson, H., Oliverio, S. & Groot, A. 2015. Vida Sana: A Lifestyle Intervention for Uninsured, Predominantly Spanish-Speaking Immigrants Improves Metabolic Syndrome Indicators. *Journal of Community Health,* 40**,** 116-123. Available: DOI 10.1007/s10900-014-9905-z.

Coppell, K. J., Tipene-Leach, D. C., Pahau, H. L. R., Williams, S. M., Abel, S., Iles, M., . . . Mann, J. I. 2009. Two-year results from a community-wide diabetes prevention intervention in a high risk indigenous community: The Ngati and Healthy project. *Diabetes Research and Clinical Practice,* 85**,** 220-227. Available: DOI 10.1016/j.diabres.2009.05.009.

Dhurandhar, E. J., Dawson, J., Alcorn, A., Larsen, L. H., Thomas, E. A., Cardel, M., . . . Allison, D. B. 2014. The effectiveness of breakfast recommendations on weight loss: a randomized controlled trial. *The American Journal of Clinical Nutrition,* 100**,** 507-513. Available: DOI 10.3945/ajcn.114.089573.

Diabetes Prevention Program Research Group 2002. Reduction in the Incidence of Type 2 Diabetes with Lifestyle Intervention or Metformin. *New England Journal of Medicine,* 346**,** 393-403. Available: DOI 10.1056/NEJMoa012512.

Dodds, A. & Chamberlain, K. 2017. The problematic messages of nutritional discourse: A case-based critical media analysis. *Appetite,* 108**,** 42-50. Available: DOI https://doi.org/10.1016/j.appet.2016.09.021.

Durie, M. 1994. *Whaiora: Maori health development. ,* Auckland, Oxford University Press.

Everson, S. A., Maty, S. C., Lynch, J. W. & Kaplan, G. A. 2002. Epidemiologic evidence for the relation between socioeconomic status and depression,

obesity, and diabetes. *Journal of Psychosomatic Research,* 53**,** 891-895. Available: DOI 10.1016/S0022-3999(02)00303-3.

Fernandez, I. D., Chin, N. P., Devine, C. M., Dozier, A. M., Martina, C. A., Mcintosh, S., . . . Yang, H. 2015. Images of a healthy worksite: A group-randomized trial for worksite weight gain prevention with employee participation in intervention design. *American Journal of Public Health,* 105**,** 2167-2174. Available: DOI 10.2105/AJPH.2014.302397.

Folta, S. C., Lichtenstein, A. H., Seguin, R. A., Goldberg, J. P., Kuder, J. F. & Nelson, M. E. 2009. The StrongWomen–Healthy Hearts Program: Reducing Cardiovascular Disease Risk Factors in Rural Sedentary, Overweight, and Obese Midlife and Older Women. *American Journal of Public Health,* 99**,** 1271-1277. Available: DOI 10.2105/AJPH.2008.145581.

Frisch, S., Zittermann, A., Berthold, H. K., Götting, C., Kuhn, J., Kleesiek, K., . . . Körtke, H. 2009. A randomized controlled trial on the efficacy of carbohydrate-reduced or fat-reduced diets in patients attending a telemedically guided weight loss program. *Cardiovascular Diabetology,* 8**,** 36. Available: DOI 10.1186/1475-2840-8-36.

Glover, M., Bosman, A., Wagemakers, A., Kira, A., Paton, C. & Cowie, N. 2013. An innovative team-based stop smoking competition among Māori and Pacific Island smokers: rationale and method for the study and its evaluation. *BMC Public Health,* 13**,** 1-8. Available: DOI 10.1186/1471-2458-13-1228.

Gutierrez, J., Devia, C., Weiss, L., Chantarat, T., Ruddock, C., Linnell, J., . . . Calman, N. 2014. Health, community, and spirituality: evaluation of a multicultural faith-based diabetes prevention program. *The Diabetes Educator,* 40**,** 214-222.

Hawthorne, K. M., Moreland, K., Griffin, I. J. & Abrams, S. A. 2006. An Educational Program Enhances Food Label Understanding of Young Adolescents. *Journal of the American Dietetic Association,* 106**,** 913-916. Available: DOI https://doi.org/10.1016/j.jada.2006.03.004.

Heart Foundation 2013. Healthy Heart a guide for health professionals.

Heymsfield, S. B., Van Mierlo, C. a. J., Van Der Knaap, H. C. M., Heo, M. & Frier, H. I. 2003. Weight management using a meal replacement strategy: meta and pooling analysis from six studies. *International Journal of Obesity & Related Metabolic Disorders,* 27**,** 537.

Honrath, K., Wagner, M. G. & Rhee, Y. 2018. Does Nutrition Education with Fruit and Vegetable Supplementation Increase Fruit and Vegetable Intake and Improve Anthropometrics of Overweight or Obese People of Varying Socioeconomic Status? *Ecology of Food and Nutrition,* 57**,** 32-49. Available: DOI 10.1080/03670244.2017.1406854.

Johnson, S. S., Paiva, A. L., Cummins, C. O., Johnson, J. L., Dyment, S. J., Wright, J. A., . . . Sherman, K. 2008. Transtheoretical Model-based multiple behavior intervention for weight management: Effectiveness on a population basis. *Preventive Medicine,* 46**,** 238-246. Available: DOI https://doi.org/10.1016/j.ypmed.2007.09.010.

Kirk, S. F. L., Penney, T. L., Mchugh, T. L. & Sharma, A. M. 2011. Effective weight management practice: a review of the lifestyle intervention evidence. *International Journal Of Obesity,* 36**,** 178. Available: DOI 10.1038/ijo.2011.80.

Klemsdal, T. O., Holme, I., Nerland, H., Pedersen, T. R. & Tonstad, S. 2010. Effects of a low glycemic load diet versus a low-fat diet in subjects with and without the metabolic syndrome. *Nutrition, Metabolism and Cardiovascular Diseases,* 20**,** 195-201. Available: DOI 10.1016/j.numecd.2009.03.010.

Lal, A., Moodie, M., Ashton, T., Siahpush, M. & Swinburn, B. 2012. Health care and lost productivity costs of overweight and obesity in New Zealand. *Australian and New Zealand Journal of Public Health,* 36**,** 550-556. Available: DOI 10.1111/j.1753-6405.2012.00931.x.

Leahey, T. M., Kumar, R., Weinberg, B. M. & Wing, R. R. 2012. Teammates and Social Influence Affect Weight Loss Outcomes in a Team‐Based Weight Loss Competition. *Obesity,* 20**,** 1413-1418. Available: DOI 10.1038/oby.2012.18.

Ma, Y., Bertone, E. R., Stanek, I. I. I. E. J., Reed, G. W., Hebert, J. R., Cohen, N. L., . . . Ockene, I. S. 2003. Association between Eating Patterns and Obesity in a Free-living US Adult Population. *American Journal of Epidemiology,* 158**,** 85-92. Available: DOI 10.1093/aje/kwg117.

McAuley, K. A., Murphy, E., Mclaymsc, R. T., Chisholmphd, A., Storybphed, G., Mann, J. I., Goulding, A. 2003. Implementation of a successful lifestyle intervention program for New Zealand Maori to reduce the risk of type 2 diabetes and cardiovascular disease. *Asia Pacific J Clin Nutr,* 12**,** 423-426.

McAuley, K. A., Williams, S. M., Mann, J. I., Goulding, A., Chisholm, A., Wilson, N., . . . Jones, I. E. 2002. Intensive Lifestyle Changes are Necessary to Improve Insulin Sensitivity: A randomized controlled trial. (Clinical Care/Education/Nutrition). American Diabetes Association. Available: http://ezproxy.massey.ac.nz/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=edsgea&AN=edsgcl.84393207&site=eds-live&scope=site.

McConnon, A., Kirk, S. F., Cockroft, J. E., Harvey, E. L., Greenwood, D. C., Thomas, J. D., . . . Bojke, L. 2007. The Internet for weight control in an obese sample: results of a randomised controlled trial. *BMC Health Services Research,* 7**,** 206-206.

McCurley, J. L., Gutierrez, A. P. & Gallo, L. C. 2017. Diabetes Prevention in U.S. Hispanic Adults: A Systematic Review of Culturally Tailored Interventions. *American Journal of Preventive Medicine,* 52**,** 519-529. Available: DOI https://doi.org/10.1016/j.amepre.2016.10.028.

McMillan-Price, J., Petocz, P., Atkinson, F., O'neill, K., Samman, S., Steinbeck, K., . . . Brand-Miller, J. 2006. Comparison of 4 diets of varying glycemic load on weight loss and cardiovascular risk reduction in overweight and obese young adults: a randomized controlled trial. *Arch Intern Med,* 166**,** 1466-75. Available: DOI 10.1001/archinte.166.14.1466.

Megson, M., Wing, R. & Leahey, T. M. 2017. Effects of breakfast eating and eating frequency on body mass index and weight loss outcomes in adults enrolled in an obesity treatment program. *Journal of Behavioral Medicine,* 40**,** 595-601. Available: DOI 10.1007/s10865-017-9828-0.

Ministry of Health 2012a. A focus on Maori nutrition. Findings from the 2008/09 New Zealand Adult nutrition survey. Wellington: Ministry of Health, .

Ministry of Health 2012b. A focus on Pacific nutrition. Findings from the 2008/09 Adult nutrition survey. Wellington, New Zealand: Ministry of Health,.

Ministry of Health 2015. Eating and activity guidelines for New Zealand adults. Wellington, New Zealand: Ministry of Health,.

Ministry of Health 2017. New Zealand Health Survey. Annual data explorer.: Ministry of Health. Available: https://minhealthnz.shinyapps.io/nz-health-survey-2016-17-annual-data-explorer/_w_e927e4c2/ - !/explore-topics.

Moore, T. J., Alsabeeh, N., Apovian, C. M., Murphy, M. C., Coffman, G. A., Cullum-Dugan, D., . . . Cabral, H. 2008. Weight, Blood Pressure, and Dietary Benefits After 12 Months of a Web-based Nutrition Education Program (DASH for Health): Longitudinal Observational Study. *J Med Internet Res,* 10**,** e52. Available: DOI 10.2196/jmir.1114.

Murphy, E., Mcauley, K. A., Bell, D., Mclay, R. T., Chisholm, A., Hurley, R., . . . Williams, S. M. 2003. A new approach to design and implement a lifestyle intervention program to prevent type 2 diabetes in New Zealand Maori. *Asia Pacific Journal Of Clinical Nutrition,* 12**,** 419-422.

Nagler, R. H. 2014. Adverse outcomes associated with media exposure to contradictory nutrition messages. *Journal of Health Communication,* 19**,** 24-40. Available: DOI 10.1080/10810730.2013.798384.

Nutbeam, D. 2008. The evolving concept of health literacy. *Social science & medicine,* 67**,** 2072-2078.

Parnell, W., Wilson, N., Thomson, C., Mackay, S. & Stefanogiannis, N. 2011. A Focus on Nutrition: Key Findings of the 2008/09 New Zealand Adult Nutrition Survey. *Ministry of Health: Wellington, New Zealand.*

Poirier, P., Giles, T. D., Bray, G. A., Hong, Y., Stern, J. S., Pi-Sunyer, F. X. & Eckel, R. H. 2006. Obesity and Cardiovascular Disease: Pathophysiology, Evaluation, and Effect of Weight Loss. *Circulation,* 113**,** 898.

Racette, S. B., Deusinger, S. S., Inman, C. L., Burlis, T. L., Highstein, G. R., Buskirk, T. D., . . . Peterson, L. R. 2009. Worksite Opportunities for Wellness (WOW): Effects on cardiovascular disease risk factors after 1 year. *Preventive Medicine,* 49**,** 108-114. Available: DOI 10.1016/j.ypmed.2009.06.022.

Sacks , F. M., Bray , G. A., Carey , V. J., Smith , S. R., Ryan , D. H., Anton , S. D., . . . Williamson , D. A. 2009. Comparison of Weight-Loss Diets with Different Compositions of Fat, Protein, and Carbohydrates. *New England Journal of Medicine,* 360**,** 859-873. Available: DOI 10.1056/NEJMoa0804748.

Sandelowski, M. 2010. What's in a name? Qualitative description revisited. *Res Nurs Health,* 33**,** 77-84. Available: DOI 10.1002/nur.20362.

Shai , I., Schwarzfuchs , D., Henkin , Y., Shahar , D. R., Witkow , S., Greenberg , I., . . . Stampfer , M. J. 2008. Weight Loss with a Low-Carbohydrate, Mediterranean, or Low-Fat Diet. *New England Journal of Medicine,* 359**,** 229-241. Available: DOI 10.1056/NEJMoa0708681.

Simmons, D., Fleming, C., Voyle, J., Fou, F., Feo, S. & Gatland, B. 1998. A pilot urban church-based program to reduce risk factors for diabetes among Western Samoans in New Zealand. *Diabetic Medicine,* 15**,** 136-142. Available: DOI 10.1002/(SICI)1096-9136(199802)15:2<136::AID-DIA530>3.0.CO;2-P.

Simmons, D., Rush, E. & Crook, N. 2008. Development and piloting of a community health worker-based intervention for the prevention of diabetes among New Zealand Maori in Te Wai o Rona: Diabetes Prevention Strategy. *Public Health Nutrition,* 11**,** 1318-1325. Available: DOI 10.1017/S1368980008002711.

Sjöström, L., Lindroos, A.-K., Peltonen, M., Torgerson, J., Bouchard, C., Carlsson, B., . . . Wedel, H. 2004. Lifestyle, Diabetes, and Cardiovascular Risk Factors 10 Years after Bariatric Surgery. *New England Journal of Medicine,* 351**,** 2683-2693. Available: DOI 10.1056/NEJMoa035622.

Tapera, R., Harwood, M. & Anderson, A. 2017. A qualitative Kaupapa Māori approach to understanding infant and young child feeding practices of Māori and Pacific grandparents in Auckland, New Zealand. *Public health nutrition,* 20**,** 1090-1098.

The Diabetes Prevention Program Research Group 2002. The Diabetes Prevention Program (DPP): Description of lifestyle intervention. *Diabetes care,* 25**,** 2165-2171.

The Gdb Obesity Collaborators 2017. Health effects of overweight and obesity in 195 countries over 25 years. *The New England Journal of Medicine***,** 13.

Tu'itahi, S. 2007. Fonua, a Pacific model. Hauroa newsletter: Hauora.

University of Otago and Ministry of Health 2011. Methodology report for the 2008/09 New Zealand adult nutrition survey. Wellington. New Zealand.: Ministry of Health,.

Wadden , T. A., Berkowitz , R. I., Womble , L. G., Sarwer , D. B., Phelan , S., Cato , R. K., . . . Stunkard , A. J. 2005. Randomized Trial of Lifestyle Modification and Pharmacotherapy for Obesity. *New England Journal of Medicine,* 353**,** 2111-2120. Available: DOI 10.1056/NEJMoa050156.

Wadden, T. A., Volger, S., Sarwer, D. B., Vetter, M. L., Tsai, A. G., Berkowitz, R. I., . . . Moore, R. H. 2011. A Two-Year Randomized Trial of Obesity Treatment in Primary Care Practice. *New England Journal of Medicine,* 365**,** 1969-1979. Available: DOI 10.1056/NEJMoa1109220.

Wing, R. R., Lang, W., Wadden, T. A., Safford, M., Knowler, W. C., Bertoni, A. G., . . . Wagenknecht, L. 2011. Benefits of Modest Weight Loss in Improving Cardiovascular Risk Factors in Overweight and Obese Individuals With Type 2 Diabetes. *Diabetes Care,* 34**,** 1481.

Womble, L. G., Wadden, T. A., Mcguckin, B. G., Sargent, S. L., Rothman, R. A. & Krauthamer-Ewing, E. S. 2004. A randomized controlled trial of a commercial internet weight loss program. *Obes Res,* 12. Available: DOI 10.1038/oby.2004.124.

World Cancer Research Fund & Research, A. I. F. C. 2007. *Food, nutrition, physical activity, and the prevention of cancer: a global perspective*, Amer Inst for Cancer Research.

World Health Organization. 2003. *Diet, nutrition and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation.* Geneva.

Wycherley, T. P., Brinkworth, G. D., Clifton, P. M. & Noakes, M. 2012. Comparison of the effects of 52 weeks weight loss with either a high-protein or high-carbohydrate diet on body composition and cardiometabolic risk factors in overweight and obese males. *Nutrition and Diabetes,* 2**,** e40.

4.0 Conclusion and recommendations

The Ka Mau Te WEHI program is a six-month Internet team-based incentivised weight loss intervention for obese Māori and Pacific Islanders with or at risk of T2DM and/or CVD. The intervention was delivered as competition in three separate regions of New Zealand. In each region seven teams of up to seven participants enrolled to compete in three competition phases where one team won a monetary prize to be donated to a charity of their choosing. The competition was assessed on both combined team weight loss results and team completion of lifestyle challenges. The intervention provided lifestyle education via the WEHI website in the form of daily tips, which amongst others included nutrition education. The participants were given daily challenges and weekly challenges to encourage lifestyle behaviour change and to increase nutrition literacy. Lifestyle and anthropometry was assessed at baseline and six months. Eating behaviour and nutrition literacy was assessed by questionnaire and weekly challenges. The aim of this sub study was to develop and assess a component of the nutrition education content for the internet team based incentivised behaviour change WEHI weight loss intervention in Māori and Pacific adults. The main findings are outlined using the objectives described in chapter one.

4.1 Main findings

- *Objective 1: To develop selected nutrition education topics for the WEHI weight loss intervention aiming to improve nutrition literacy and eating behaviours.*

Nutrition education content on selected topics was developed in the form of some of the daily tips and weekly challenges that was used across the intervention. The topics covered label reading, mindful eating, portion sizes, meal patterns, social eating and motivational declines. Eight nutrition related weekly challenges were developed **Table 9.** The topics included portion sizes, reading food labels, the food environment, breakfast and snack foods, sugar content of food and healthier traditional recipes. The topics of both the challenges and tips were chosen to educate the participants on key eating behaviours for healthy eating and weight loss and to support the participants in achieving the daily challenges. The topics also addressed key eating behaviours of concern in the target population (Ministry of Health, 2012a, Ministry of Health, 2012b). Additionally the education was developed in accordance with national guidelines from the Ministry of

Health and the Heart Foundation. The education provided practical examples of how to implement the recommendations into everyday practice. The educational content is in line with the content of successful lifestyle interventions. However, the delivery through daily tips and weekly challenges differed significantly from formal nutrition education programs that are common in lifestyle interventions. The daily tips were posted on the program webpage and the weekly challenges were sent to each team. There was no interaction with trained nutrition staff other than through the daily tips and weekly challenges. Therefore there was no opportunity to clarify the nutrition education or gain further understanding.

- *Objective 2: To assess the change in nutrition literacy achieved using the developed content.*

Nutrition literacy was assessed in the questionnaires and weekly challenges. Understanding of energy density increased from baseline to six months; there was a 13.3% increase in participants able to identify an energy dense food from a list. Participants overall had a good understanding of food groups as assessed in a weekly challenge. The majority of teams successfully completed label-reading activities. However, participants struggled most with the concept of comparing nutritional content in terms of 100g. In terms of food preparation the majority of participants were able to identify healthy cooking methods from unhealthy cooking methods at baseline. The improvements in nutrition literacy are in line with other educational interventions.

- *Objective 3: To assess change in eating behaviours achieved using the developed content.*

The participants showed behaviour change in key eating behaviours for healthy eating and weight loss. From baseline to six months there was a reduction in sugar sweetened beverage consumption. The number of days eating healthy unprocessed foods such as fruit, vegetables, legumes, lean meat and fresh seafood increased significantly. The number of days eating high energy foods such as fast food, snack chips or crackers and desserts and sweets decreased significantly (*$p<0.00$), ($p=0.026$)* and *($p=0.002$)*.

Additionally, the number of participants who met national guidelines for fast food, fruit and vegetable consumption increased. From baseline to six-months there was a decrease in participants adding salt and fat to foods. From the focus groups it was deduced that participants found portion sizes challenging to reduce. They were however aware of their behaviour in regards to portion sizes. A factor in this challenge may be related to ingrained cultural norms that require further support and education to overcome. Participants stated that resulting from the intervention they had tried new foods and incorporated them into their diet. Their households had had also stopped consuming other foods such as sugar-sweetened beverages and biscuits. These eating behaviour changes are a significant improvement and in line with or exceed that of other interventions that do not provide a strict eating program. The nutrition education and the self-directed nature of the program might not have been adequate to achieve a sufficient calorie deficit to achieve weight loss.

- *Objective 4: To assess the acceptability of the nutrition education component within the WEHI weight loss intervention.*

From the focus group discussions, it was found that participants did not use the website every day and often did not read the tips of the day. Topics that participants did find useful included the sugar content of beverages and portion sizes. Participants enjoyed the challenges that involved experimenting with and preparing different foods. How the nutrition education was delivered was not however deemed acceptable. Participants felt that having to go on to the website and find the tips was inhibiting the usability of the program. They would have preferred that the tips were sent to them and ideally notifications to remind them to read them and complete challenges.

This study was completed before the final follow-up results could be analysed. From the results available there was no significant weight loss achieved at six months.

Feedback

Focus groups conducted with participants after the six-month intervention identified key feedback areas. Not all participants joined the competition to lose weight and change

behaviour. The participants all mentioned being motivated initially by the points and the competition to win the money for a charity. Additionally, having the WEHI diary to use daily was considered to be a useful motivating tool. However, of the two teams that completed focus groups only the highly competitive team remained motivated for the whole competition. Website usage decreased over time, some participants did not use the website more than twice during the intervention. One of the teams was unaware of the lifestyle changes that they had made until the focus group helped them to understand the changes.

4.2 Strengths

The use of Māori models of health- in the design of the program, using regional coordinators, team based competition and culturally relevant education.

Form of daily tips – a new tip posted each day.

Nutrition education- focused on key concerning eating behaviours identified in the target population. Furthermore, the nutrition education was delivered in innovative ways, through short tips and weekly challenges, which involved practical team and individual learning. Peer learning provides social support and has been shown to promote behaviour change in lifestyle interventions (Leahey and Wing, 2013, Leahey *et al.*, 2012).

4.3 Limitations

Tools for assessing knowledge and behaviour - food literacy was not assessed using a validated tool, therefore food literacy levels could not be compared to the wider population.

Website usage - the majority of the nutrition education was posted on the program webpage. A major limitation of this study was that there was no control measures conducted to assess whether participants actually read or used all the daily tips provided. Participants also reported not using the website daily.

High dropout rate and lack of availability of data - this program experienced a high attrition rate. As discussed there was no measures conducted to assess use of the

program materials. Therefore, participants who were not using the program but completed the six-month follow up may have been included in the completers. This may have diluted the effect of participation in the program.

Finally, this sub-study was completed before the 48-week data was available, so maintenance of eating behaviours could not be assessed. Additionally, further feedback on acceptability of nutrition education was not available due to the timing of this sub-study.

4.4 Contribution of this study to health in this area

The key findings of this sub-study can be related to this area of research.

The knowledge that this population group has a high intake of energy dense foods, are family focused, and enjoy competitive activities has been reinforced. Furthermore, this study has reinforced the knowledge that online lifestyle interventions are not as effective in producing weight loss or maintaining program involvement as interventions with more individual support. This study also reinforced the need for empowerment, education as well as the use of behaviour change models.

This study has identified that it is possible to significantly reduce consumption of high-energy foods without intensive individual health interventions or strict dietary prescription in this population group.

4.4 Recommendations for further research in this area

- Conducting an Internet based intervention with more user-friendly technology and providing participants with notifications and reminders to complete challenges.
- Providing user-friendly education material in various formats including work sheets and tips in the form of individual and peer learning and monitoring its use to assess viability of the methods employed.
- Utilise personal monitoring of behaviour in the form of a diary, however make the behaviours within the diary stronger to achieve better weight loss outcomes.

- Provide consistent nutrition education in-line with national guidelines and evidenced based lifestyle intervention weight loss recommendations. Additionally, further emphasize the importance of and how to achieve an energy deficit to achieve weight loss.
- Inclusion of a team group discussion with a nutrition expert to discuss appropriate behaviour, lifestyle and dietary changes may be beneficial.
- Address key barriers including the holiday period, social pressures and decrease in motivation over time.
- Use validated tools in assessment of key areas including food literacy and eating behaviours in order to compare the findings to the wider population.
- Investigate the effect of SES on healthy eating behaviour changes within culturally appropriate lifestyle interventions in Māori and Pacific populations in New Zealand
- A longer-term competition needs more achievable incentives for a broad range of individuals and /or teams to be sustainable.

Conclusion

This is the first internet team-based, incentivised weight loss intervention aimed at reducing the risk of cardiovascular disease and type two Diabetes Mellitus in Māori and Pacific adults. A key finding from the literature review was the lack of successful community based weight loss interventions specifically for Māori and Pacific adults in New Zealand. The overall study design was attractive to the target population, enabling successful recruitment of a large intervention population group. However, the study experienced a large attrition rate. Reduced use of program tools over time may have led to participants not receiving adequate nutrition education to achieve dietary changes sufficient to achieve weight loss. This sub-study successfully improved key eating behaviours associated with increased risk of chronic disease from baseline to six months. To build on these behaviour changes further research in this area is warranted.

References

Leahey, T. M., Kumar, R., Weinberg, B. M. & Wing, R. R. 2012. Teammates and Social Influence Affect Weight Loss Outcomes in a Team‐Based Weight Loss Competition. *Obesity,* 20**,** 1413-1418. Available: DOI 10.1038/oby.2012.18.

Leahey, T. M. & Wing, R. R. 2013. A randomized controlled pilot study testing three types of health coaches for obesity treatment: Professional, peer, and mentor. *Obesity,* 21**,** 928-934. Available: DOI 10.1002/oby.20271.

Ministry of Health 2012a. A focus on Maori nutrition. Findings from the 2008/09 New Zealand Adult Nutrition Survey. Wellington: Ministry of Health.

Ministry of Health 2012b. A focus on Pacific nutrition. Findings from the 2008/09 New Zealand Adult Nutrition Survey. Wellington, New Zealand: Ministry of Health,.

Subar, A. F., Kipnis, V., Troiano, R. P., Midthune, D., Schoeller, D. A., Bingham, S. Ballard-Barbash, R. 2003. Using intake biomarkers to evaluate the extent of dietary misreporting in a large sample of adults: the OPEN study. *American journal of epidemiology,* 158**,** 1-13.

Chapter 5.0 Appendices

Appendix A. Supplementary methods

This sub-study did not assess the full outcomes of the Ka Mau Te WEHI program. Analysis and discussion of the full program will be conducted by the larger research team, included questionnaire questions not included in this sub-study. From the questionnaire it was apparent that a food-ranking question was not understood and answers could not be accurately assessed, therefore this question was excluded from the analysis.

Questionnaires were piloted with three Māori and three Pacific individuals to test comprehension levels; some adjustments were made following this.

The regional coordinators were responsible for recruiting participants, providing teams with the weekly challenges, collecting the weekly results and organising the weigh-ins at the end of each two-month phase.

Appendix A.1: Breakfast food groups from the questionnaire

Category	Food	Foods included
Protein	Meat	Chicken, Salmon, beef
Protein	Processed meat	Bacon, sausages, pork schnitzel, ham, corned beef, corned silverside
Protein	Eggs	All cooking methods
Protein	Legumes	Baked beans, peanut butter
Protein	Dairy	Milk, yoghurt, cream, cheese, nut milks
Protein	Low fat dairy	Low fat milk
Protein	Nuts and seeds	
Protein	Smoothie	Dairy based smoothies, up and go, protein smoothies
Carbohydrate	Starchy vegetable	
Carbohydrate	Grains	Breads, crackers, pancakes, tabbouleh
Carbohydrate	Muesli and cereal	Nutrigrain, muesli, special K, cornflakes, Allbran, muesli bar
Carbohydrate	Weetbix, porridge	
Vegetable	Non-starchy vegetables	Tomato, spinach, salad, kale, avocado, sweetcorn, carrots
Fruit	Fresh fruit	Fresh fruit, berries
Take-away	All types	Pie, breakfast combos, chicken and chips
Other	Baking	Scone, muffin, cake
Other	Leftovers	Leftovers from dinner meal, chicken curry
Other	Added sugar	Sugar, jam, maple syrup, marmalade, honey, brown sugar
Beverage	Tea and coffee	Tea, herbal tea, instant coffee, coffee sachet, coffee
Beverage	Café drinks	Mochacino, milky drinks, latte, hot chocolate, soy latte
Beverage	Fruit juice	Fruit juice, fruit and vegetable smoothie

Appendix B. Supplementary results

Appendix B.1: Eating behaviour questionnaire results baseline and six months

	Baseline		Six months		Change	
How often do you have a drink containing added sugar?	**n**	**%**	**n**	**%**	**n**	**%**
I don't drink sugar sweetened beverages	14	23.3	23	38.3	9	15.0
Once per week	8	13.3	18	30.0	10	16.7
2-5 times per week	22	36.7	13	21.7	-9	-15.0
1 a day	6	10.0	3	5.0	-3	-5.0
2 or more a day	10	16.7	2	3.3	-8	-13.3
Missing	0	0.0	1	1.7	1	1.7
How much unflavoured water do you drink on a usual day?						
1.5L or less	50	83.3	48	80.0	-2	-3.3
2L or more	9	15.0	12	20.0	3	5.0
Missing	1	1.7	0	0.0	-1	-1.7
In the last 7 days how many days did you eat fruit?						
0	5	8.3	2	3.3	-3	-5.0
1 to 3	20	33.3	14	23.3	-6	-10.0
5 to 6	16	26.7	19	31.7	3	5.0
7	13	21.7	24	40.0	11	18.3
Missing	6	10.0	1	1.7	-5	-8.3
How many servings of fruit do you eat each day on average?						
0-1 serves	25	41.7	16	26.7	-9	-15.0
2 serves	23	38.3	19	31.7	-4	-6.7
3-4 serves	12	20.0	17	28.3	5	8.3
5+ serves	0	0.0	8	13.3	8	13.3
In the last 7 days how many days did you eat vegetables?						
0 days	1	1.7	0	0.0	-1	-1.7
1-3 days	21	35.0	14	23.3	-7	-11.7
5-6 days	16	26.7	14	23.3	-2	-3.3
7 days	17	28.3	30	50.0	13	21.7
Missing	5	8.3	2	3.3		-5.0
How many servings of vegetables do you eat each day on average?						
0 serves	2	3.3	1	1.7	-1	-1.7
1-2 serves	36	60.0	27	45.0	-9	-15.0
3-4 serves	15	25.0	18	30.0	3	5.0
5 serves	4	6.7	5	8.3	1	1.7
6+ serves	1	1.7	7	11.7	6	10.0
Missing	2	3.3	2	3.3	0	0.0
How often do you choose low or reduced fat varieties of food?						
Every day	5	8.3	0	0.0	-5	-8.3

2 to 3 times per week	20	33.3	16	26.7	-4	-6.6
2 times per month or less	32	53.3	33	55.0	1	1.7
Missing	3	5.0	11	18.3	8	13.3
How often do you add salt to food after it has been cooked or prepared?						
Never or rarely	26	43.3	28	46.7	2	3.3
Sometimes	12	20.0	19	31.7	7	11.7
Often or all the time	22	36.7	11	18.3	-11	-18.3
Missing	0	0.0	2	3.3	2	

	Baseline		**Six months**			
	n	**%**	**n**	**%**		
During the last 7 days how many times did you…						
Eat fast food meals or snacks?						
0	2	3.3	11	18.3	9	15.0
Once	13	21.7	17	28.3	4	6.7
2 to 5 times	40	66.7	29	48.3	-11	-18.3
6 to 7 times	4	6.7	2	3.3	-2	-3.3
Missing	1	1.7	1	1.7	0	0.0
Eat regular snack chips or crackers?						
0 to once	24	40.0	38	63.3	14	23.3
2 to 4 times	27	45.0	17	28.3	-10	-16.7
5 to 7 times	9	15.0	4	6.7	-5	-8.3
Missing	0	0.0	1	1.7	1	1.7
Eat desserts and other sweets?						
once or less	12	20.0	29	48.3	17	28.3
2 to 4 times	38	63.3	23	38.3	-15	-25.0
5 to 7 times	9	15.0	7	11.7	-2	-3.3
Missing	1	1.7	1	1.7	0	0.0
Eat lean meat?						
once or less	16	26.7	6	10.0	-10	-16.7
2 to 5 times	41	68.3	48	80.0	7	11.7
6 times	2	3.3	3	5.0	1	1.7
7 times	0	0.0	1	1.7	1	1.7
Missing	1	1.7	2	3.3	1	1.6
Eat fresh seafood?						
0 times	22	36.7	15	25.0	-7	-11.7
Once	18	30.0	15	25.0	-3	-5.0
Twice	12	20.0	12	20.0	0	0.0
3 to 7 times	8	13.3	16	26.7	8	13.3
Missing	0	0.0	2	3.3	2	3.3
Eat legumes?						
0 times	39	65.0	26	43.3	-13	-21.7
1 to 3 times	19	31.7	28	46.7	9	15.0
4 to 5 times	0	0.0	4	6.7	4	6.7
7 times	1	1.7	1	1.7	0	0.0
Missing	1	1.7	1	1.7	0	0.0

Have something to eat for breakfast?						
0 to once	8	13.3	9	15.0	1	1.7
2 to 4 times	18	30.0	11	18.3	-7	-11.7
5 to 6 times	10	16.7	12	20.0	2	3.3
7 times	24	40.0	26	43.3	2	3.3
Missing	0	0.0	2	3.3	2	3.3
How often do you have a drink containing alcohol?						
I don't drink alcohol	17	28.3	17	28.3	0	0
Less than once monthly	25	41	23	38	-2	-3
1-3 times per month	12	20	10	16.7	-2	-3.3
≥1/week	5	8.3	9	15	4	6.7

Appendix B.2: Questionnaire results nutrition literacy

Which of the following foods would you choose

	Baseline	**Six months**	**Change**
	n(%)	n(%)	n(%)
2 Chicken drumsticks	23(38.3)	39(65.0)	16(26.7)
1 Chicken breast	33(55)	17(28.3)	-16(-26.7)
2 Sausages	9(15)	49(81.7)	40(66.7)
1 lamb shank	46(76.7)	8(13.3)	-38(-63.3)
4 Slices bread	22(36.7)	25(41.7)	3.0(5.0)
2 rolls	31(51.7)	30(50.0)	-1.0(-1.7)
1/2 cup pasta	16(26.7)	27(45.0)	11(18.3)
1 cup pasta	25(41.7)	25(41.7)	0.0(0.0)
2 cups pasta	10(16.7)	5(8.5)	-5.0(-8.3)
1 kumara	37(61.7)	44(73.3)	7.0(11.7)
2 potatoes	6(10)	6(10)	0.0(0.0)
1 cup mashed potato	9(15.0)	7(11.7)	-2.0(-3.3)
1 muffin	20(33.3)	29(48.3)	9.0(15.0)
2 slices cake	18(30.0)	9(15.0)	-9.0(-15.0)
4 ginger nuts	11(18.3)	16(26.7)	5.0(8.3)

Appendix B.3: Weekly challenge what type food is it results.

Food group	Correct	Incorrect
Grains and starchy vegetables		
Noodles	14(100)	0(0)
Taro	14(100)	0(0)
Rice	14(100)	0(0)
Oats	14(100)	0(0)
Bread	13(93)	0(0)
Potato	13(93)	1(7)
Quinoa	11(79)	2(14)
Vegetables		
Puha	14(100)	0(0)
Onion	14(100)	0(0)
Coriander	14(100)	1(7)
Fruit		
Apple	14(0)	0(0)
Banana	13(93)	0(0)
Orange juice	9(64)	3(21)
Meat, fish and legumes		
Pork	14(100)	0(0)
Chicken	13(93)	0(0)
Hamburger	12(86)	1(7)
Pipi	12(86)	2(14)
Lentils	5(36)	9(64)
Chickpea	5(36)	9(64)
Dairy		
Cheese	14(100)	0(0)
Milk	14(100)	0(0)
Yoghurt	14(100)	0(0)
Fats and oils		
Salad dressing	14(100)	0(0)
Butter	12(86)	1(7)

Appendix B.4: Full focus group theme results

Theme	Question	– Discussion topics
Overall experience	Did you get what you wanted out of the program	– Yes weight loss – No we didn't lose weight – Yes wanted to do something with my family
	Did you use the website	– Yes every week – Once or twice – More at the beginning and then less – Used team Facebook page more – Looked at the points of other teams – Posted on team page – Read the tips especially stress related – Forgot to read the tips – Sent tips to other team members
Barriers and motivators	Did you stay involved for the whole program	– Yes we needed to win – Not over the Christmas period – Lots of bbqs and birthdays over Christmas – Did not go on holiday so we wouldn't lose points – Dropped motivation after not winning
	Did anything stop you from being involved in the competition?	– Getting sick – Financial stress – Family stress – Time hard to exercise with young kids – Hard to get the team together every week – Hard to keep going after loosing
Support	Did anyone outside your team support you?	– Friends and colleagues wouldn't offer junk food or sweets – Mostly support from the team
Behaviour change and knowledge	What was useful to help make healthy food choices?	– The diary, having to tick of the points was motivating – Tips about sugar in drinks, portion sizes – Having to try new food – Food environment challenge – The competition
	Did anyone outside the program change their behaviour?	– Family members not in the team – No sugar in the house
	Has anyone been able to make changes to portion sizes?	– Yes we do it everyday – No its really hard, easier at breakfast and lunch, often over eat at dinner – Plate stickers as a reminder – Over eating when too hungry in the evening
	Are you continuing any of the changes you made?	– Drinking water – Not have sweet drinks – Portion sizes – Salads at work lunches – Taking the train instead of driving to

		work – Eating breakfast – Having vegetables
	Do you feel you know how to make healthy food choices?	–
Competition challenges	Which daily challenges were the hardest?	– Sweet treat free day – Fast and fried free day – Sugar sweetened beverages – exercise
	Which weekly challenges stood out to you?	– Cooking ones – Trying new foods – Food environment, found a new vegetable shop by work
Improvement areas	How to make the program more Pacific	– Better celebration and recognition – Telling them what they can eat – Targeting families
	feedback	– Tips were hard to find – Phone app with notifications would be easier – More recognition/celebration – More recipe ideas – Short tips were good

Appendix C. Questionnaires and materials

Appendix C.1: Author guidelines (Nutrition reviews)

Narrative Reviews. Reviews of this type should contain the following sections and headings in addition to the abstract:

- Introduction (directly following the abstract)
- Conclusion (at the end of the text)
- Acknowledgements (after the Conclusion)
- Funding and sponsorship (as part of the Acknowledgments)
- Declaration of interest (as part of the Acknowledgments)
- References (after the Acknowledgments).

Between the Introduction and Conclusion, headings and subheadings are at the discretion of the author. They should be used to organize the text and guide the reader.

Length restrictions. Articles in any category must be formatted as indicated in the Manuscript format guidelines section and may not exceed 50 double-spaced pages in length, including references and illustrative material. Each article should be a focused, concise, and objective investigation of a clearly defined topic. The option to publish certain material as "Supporting Information" in an online-only format is provided, as outlined here. Authors are encouraged to make use of this option to accommodate material that may be of interest to the reader but is not integral to the work itself. Examples would include extensive summary tables and appendices.

Manuscript format. Manuscripts should be prepared electronically using word-processing software, preferably Microsoft Word. Article pages should be formatted as double-spaced and left-justified text with 1-inch margins and 12-point type. Pages and lines must be numbered.

Tables and illustrations. Tables and illustrations should be numbered in the sequence in which they appear in the text. They should appear in sequence after the reference list.

Tables. All tables should be included in the text file after the reference list. Each table should be constructed using the table functions of the word-processing program being used. A title should appear at the top of each table. A column heading should appear in the top cell of each column. Within the table, each data set should appear in a single cell; the return key should not be used within any cell. Text should be justified to the left. Numerical data should be justified to the decimal point. Capitalization should be restricted to the first letter of the legend, the first letter in each cell, and applicable abbreviations or acronyms. Abbreviations used in the table should be spelled out in a footnote. When citing prior studies in tables please use the following format: Smith et al. (1998)[21].

Illustrations. All artwork should be submitted in digital format in separate files saved using the following convention: surname of first author figure number (e.g., Smith figure 1). Figure legends should be cited in the manuscript after the reference list. Charts and graphs downloaded from the Internet are not acceptable. Line artwork (vector graphics) should be saved in Encapsulated PostScript (EPS) format and bitmap files (halftones or photographic images) in Tagged Image Format (TIFF), with a resolution of at least 300 dpi at final size. Do not send native file formats. More detailed guidance for submitting electronic artwork can be found at http://www.blackwellpublishing.com/bauthor/illustration.asp. A free tool for converting files to other formats can be located at www.zamar.com.

References. The number of references cited should be tailored to the material being reviewed and be from reputable sources. As a general rule, articles in the Lead, Special, and Nutrition Science -> Policy categories do not typically include more than 200 references, while articles in the Emerging Science and Nutrition in Clinical Care categories do not typically have more than 120. References should be numbered sequentially upon first appearance in text, tables, and figures. They should be typed as superscripts and placed after commas and periods but before colons and semicolons. References cited only in figure or table legends should be numbered according to the first mention of the graphic in the text. Reference to unpublished work or personal communications should be avoided but, when essential, should be identified in the text as “unpublished data” or

“personal communication from ...”, not in the reference list. When citing a series of consecutive numbers, provide the first and last with a dash between them (e.g., 5–7). When referring to a group of authors in the text, the format “Smith et al.[23]” should be used.

References cited only in figure or table legends should be numbered according to the first mention of the graphic in the text and should be cited in the text at that point. Reference to unpublished work or personal communications should be avoided but, when essential, should be identified in the text as “unpublished data” or “personal communication from ...”, not in the reference list. To ensure long-term accessibility, internet citations should only be used if that is the sole source of the information.

The reference list should be formatted according to AMA style. For each citation, sufficient information must be provided to allow a reader to know in what medium the material appeared and to access the information. Please list all authors if there are six or fewer; for seven or more authors, list the first three followed by “et al.”

Appendix C.2: Author Guidelines (Asia Pacific Journal of Clinical Nutrition)

Style Manuscripts should follow the style of the Vancouver agreement detailed in the 'Uniform Requirements for Manuscripts Submitted to Biomedical Journals', as presented in JAMA 1997;277:927–34 (www.acponline.org/ journals/anals/01jan97/unifreqr.htm). APJCN uses US/ UK spelling and authors should therefore follow the latest edition of the Merriam–Webster's Collegiate Dictionary/Concise Oxford Dictionary. Please indicate your preference and use one or the other exclusively. If you do not specify, by default UK spelling will be used. A Guide for Medical and Scientific Editors and Authors (Royal Society of Medicine Press, London). Abbreviations should be used sparingly and only where they ease the reader's task by reducing repetition of long, technical terms. Initially use the word in full, followed by the abbreviation in parentheses. Thereafter use the abbreviation. At the first mention of a chemical substance, give the generic name only. Trade names should not be used. Drugs should be referred to by their generic names, rather than brand names. For vitamins, notation use is B-2, B-2, B-3, B-6 and B- 12 not B1, B2, B3, B6 and B12. "Fetal" is more etymologically correct than "Foetal". Note style for probability: p

Abstract and key words: The abstract should be structured with Background and Objectives, Methods and Study Design, Results, and Conclusions in 250 words or less. The abstract should not contain abbreviations or references. Five key words should be supplied below the abstract. Text Authors should use subheadings to divide the sections of their manuscript: INTRODUCTION, MATERIALS AND METHODS, RESULTS, DISCUSSION, ACKNOWLEDGMENTS, REFERENCES. Numerical results and p values should be presented in text, tables and figures with no more than 3 significant figures, unless there are exceptional circumstances. Examples would be: 52.37 kg which should be 52.4 kg p=0.15234 which should be p=0.152 Authors can make a case that their methodology requires further exception to these guidelines.

Tables: should be self-contained and complement, but not duplicate, information contained in

the text. Each table must be formatted by using the table feature in WORD and presented as a separate file with a comprehensive but concise heading. Tables should be numbered consecutively in Arabic numerals in the sequence in which they are mentioned in the text. Use a single top rule, a single rule below the headings, and a single bottom rule. Do not use rules within the table body. Column headings should be clearly delineated, with straddle rules over pertinent columns to indicate subcategories. Column headings should be brief, with units of measurement in parentheses; all abbreviations should be defined in footnotes. Footnote symbols: †, ‡, §, ¶, ††, should be used (in that order) and *, **,*** should be reserved for p values. The table and its legend/ footnotes should be understandable without reference to the text. All lettering/ numbers used in tables should be font style 'Times New Roman' and font size 8.5 or 9.

Figures: All illustrations (line drawings, bar charts and photographs) are classified as figures. Figures should be cited in consecutive order in the text. Figures should be sized to fit within the column (85 mm), intermediate (114 mm) or the full text width (177 mm). Line figures or bar chart figures should be drawn in a computer graphics package (e.g. EXCEL, Sigma Plot, SPSS etc.). All lettering used in figures should be font style 'Times New Roman' and font size 9.

Appendix C.3: Participant information sheet

Ka Mau Te Wehi:

Weight Loss, Eating Healthy and Increasing Exercise

Participant Information Sheet

You are invited to take part in a study testing a new program designed to help people lower ill-health effects of being obese. This test program is for Māori and Pacific people who are overweight and at-risk for, or who have already been diagnosed as having Diabetes Type 2 or heart health problems.

Why are we doing this study?

In New Zealand, nearly half of Māori adults and nearly two-thirds of Pacific adults can be are classified as obese based upon how much they weigh against how tall they are. The Government has made it a priority to find a way to reduce these numbers because a higher proportion of Māori and Pacific people are obese than other New Zealanders. People who are obese have a higher chance of developing long term health problems such as heart disease, diabetes and cancer. Losing some weight can help prevent or at least lower the development of these diseases.

The purpose of this study is to test a new way to encourage people to lose weight and better control weight on an ongoing basis through healthier eating and increasing physical activity. The program is based on Māori and Pacific values and previous behaviour change programs that have worked for them.

To find out if the new program works, some participants will take part in a team weight-loss competition, and some participants will be a comparison group that will not take part in the competition. This is a standard way of testing if a program works. The people who do not do the program are as important as the people who do the program in this study. People who cannot or do not want to take part in the team weight-loss competition will be asked to be part of the comparison group.

How does the weight-loss competition work?

There will be 3 competitions: 1 in Auckland for Pacific people, 1 in Northland for Māori and 1 in Palmerston North/Manawatu for Māori. Seven teams of 7 people are needed in each region. Every region will have a research assistant who will provide support relating to the study however each team will be self-directed in terms of organising their own team meetings and activities. Information on the steps to follow in the weight loss program, such as the daily and weekly challenges, will be provided to the competing teams through the research assistant and through a publicly available website. The daily and weekly challenges are designed to help participants achieve their goal of losing

weight and maintaining that weight loss. The website will display the progress of each team on a competition scoreboard. Every team will also have a dedicated team page where they can post questions for the researchers and support each other. The winning team is calculated based on weight loss, reduction in waist circumference and the completion of daily and weekly challenges. The competition will run for 6 months and there will be a follow-up survey 6 months after the end of the competition.

At the end of the study we will be looking to evaluate the intervention. You may be invited to provide feedback on the intervention if you participated in the competition.

How does the comparison group work?

Fifty people in each region are needed to provide a comparison group. Comparison group participants will be asked to do the same measurements and questionnaires at the beginning of the study, at six months and 12 months. If you agree to be part of the comparison group, you can just keep doing everything as you usually do. The comparison group will not receive any information on how to lose weight.

Who is being invited to participate?

This study involves New Zealand men and women aged 16 years and older who meet the classification for being obese (that is, a Body Mass Index score of 30 or over). Participants must also fit the following criteria:

be at risk of developing diabetes, or have been diagnosed with type 2 diabetes OR be at risk of cardiovascular disease or have been diagnosed with cardiovascular disease

be enrolled or be willing to enrol with a primary health care provider (there is no cost to enrol with a primary health care provider)

be willing to present their doctor with a letter to organise a blood test for HbA1c and cholesterol at the beginning of the study, at 6 months and at 12 months.

You will not be able to participate in the study if:

you are under 16 years old

are pregnant or planning a pregnancy within the next year

currently smoke tobacco, vape nicotine or use nicotine replacement products

have had a live baby in the past six months, and are still breastfeeding.

You may have been invited to take part in this study through a doctor, nurse or community health worker. Community health workers will be advertising the study through medical clinics, community organisations, churches, schools, marae, or sports clubs.

Do I have to take part in this study?

Your participation in this research project is entirely your choice. If you do not want to take part, you do not have to. If you agree to take part in this study and later change your mind, then you may withdraw at any time up to the end of the 12 month follow up without giving a reason, however, you cannot withdraw any information about your team activities or their success. If you do wish to take part, you will be asked to sign a Consent Form. If you decide to withdraw from the study, please tell the research team (details below) by phone, email or in writing that you wish to withdraw.

What is involved?

If your doctor or nurse told you about the study, they may know that you are eligible. If you heard about the study another way, a WEHI research assistant will need to check if you are eligible. They may need to meet with you to measure your weight and height. You will then be asked to complete a short questionnaire asking about your age and if you smoke or not. This information will allow us to decide if you are eligible to take part in the study.

If you are eligible to take part and have given written consent that you agree to take part you will be asked to complete another detailed questionnaire so we can collect more information about you, your activity levels and your eating habits. You will then be required to visit your Doctor to have a blood test to measure your HbA1c and cholesterol levels. If you have recently had these blood tests we can give you a letter to give to your Doctor asking them to share the blood test results with us.

At the end of the six month competition period everyone will have their weight and waist circumference measured again by the WEHI research assistant and the same blood tests will need to be done again.

Regardless of which group you are in, twelve months after starting the research, everyone will be asked to fill in the last questionnaire, have your physical measures taken and your blood drawn one last time.

What are the costs of taking part?

Some of the requirements for this study may be part of standard care used to maintain your health even if you did not take part in this study. We will cover the cost of any study-related tests and appointments not already covered as part of your standard care; these include blood tests and Doctor's visits. All the necessary arrangements will be arranged through the research assistant.

WEHI competition group members are encouraged and supported to use whatever non-surgical methods, diets, programs or health and fitness providers they want and can access at their own cost.

What about my privacy?

Any information you supply in a questionnaire or interview with the researchers will be confidential and any information that could identify you will be removed. No information that could personally identify you will be used in any reports from this study. The results will be stored indefinitely on computer in case there is a future need to analyse the data,

but it will not contain names, addresses or any other information that could identify you. All computerised information will be password protected on a computer located in the Principal Investigator's locked office at the Massey University Albany Campus. Only the research team will have access to your data. All paper questionnaire forms will be destroyed after 6 years.

The results will be reported to the health provider who provided WEHI research assistance in each region and the NZ Ministry of Health who are funding the study.

Confidentiality cannot be guaranteed for any information you share with your team.

What are the benefits and risks of the study?

Receiving information and support to lose weight can reduce the risk of heart disease and diabetes. In the long term, results from this study will help inform ways of reducing obesity for all communities. There may also be a benefit to participants in the competition if their team wins, as the prize money goes to their chosen charity.

There is a risk that participants may feel pressure from other team members to lose weight and might feel some shame, guilt, disappointment or sadness if they do not succeed at losing weight. If you have any concerns about how you are feeling please talk to your WEHI research assistant, or email or phone Associate Professor Marewa Glover (details below). You may also feel mild pain/bruising at the site of blood testing.

What if something goes wrong?

If you are injured in this study, which is unlikely, you would be eligible for compensation from ACC just as you would be if you were injured in an accident at work or at home. You will have to lodge a claim with ACC, which may take some time to assess. If your claim is accepted, you will receive funding to assist in your recovery. If you have private health or life insurance, you may wish to check with your insurer that taking part in this study won't affect your cover.

Research findings

A summary of the research findings will be given to you if requested on your consent form.

Contact persons

If you have any questions, concerns or complaints about the study at any stage you can contact the following researchers at Massey University:

Associate Professor Marewa Glover
Principle Investigator

School of Public Health

Massey University

P: +64 9 213 6059

M: 027 27 57 852

El: m.glover@massey.ac.nz

Professor Roger Hughes

Head of School

School of Public Health

Massey University

P: +64 (04) 801 5799 ext. 63398

E: r.hughes@massey.ac.nz

If you have any queries or ethical concerns regarding your rights as a participant in this study, you may wish to contact:

The Chair

Health and Disability Ethics Committee

Ministry of Health

PO Box 5013, Wellington, 6011

0800 4 ETHICS

hdecs@moh.govt.nz

For Māori health support, please contact:

Fay Selby-Law

Te Wakahuia Manawatu Trust, Kaiarahi – Te Ohu Auahi Mutunga

P: +64 (06) 354 3423

E: fay@tewakahuia.org.nz

For Pacific health support, please contact:

Mafi Funaki-Tahifote

Pacific Heartbeat, Operations Manager

P: +64 (09) 571 4665

E: MafiT@heartfoundation.org.nz

Thank you very much for your time and help in making this study possible.

You may keep this page for your records.

Appendix C.4: Participant consent form

3Ka Mau Te Wehi:

Weight Loss, Eating Healthy and Increasing Exercise

Consent Form

I have read the Participant Information Sheet, have understood the nature of the project and why I have been selected. I have had the opportunity to ask questions and have them answered to my satisfaction. I understand that there may be risks associated with participating in the study.

I understand that taking part in this study is voluntary my choice and that I may withdraw from the study at any time. I understand that my participation in this study is confidential and that no material, which could identify me personally, will be used in any reports on this study. However, I also understand that if I decide to withdraw from the study, I agree that the information collected about me up to the point when I withdraw may continue to be processed.

I consent to the research staff collecting and processing my information, including information about my health.	Yes ☐	No ☐
I have a primary healthcare provider. Please provide name:	Yes ☐	No ☐
I agree to a laboratory drawing 3 blood samples at 6 month intervals from me for HbA1c and cholesterol testing and I am aware that these samples will be disposed of using established guidelines for discarding biohazard waste.	Yes ☐	No ☐
I authorize the release of my blood results to the WEHI research team for the purposes of the WEHI project. Information may be used for research without identifying me in any way.	Yes ☐	No ☐
I understand my responsibilities as a study participant.	Yes ☐	No ☐
I would like a summary of the results, if yes, please provide your email:	Yes ☐	No ☐

Declaration by participant:

I hereby consent to take part in this study.

Participant's name:

Signature: Date:

Declaration by member of research team:

I have given a verbal explanation of the research project to the participant, and have answered the participant's questions about it.

I believe that the participant understands the study and has given informed consent to participate.

Researcher's name:

Signature: Date:

Appendix C.5. Baseline questionnaire

1 What region do you live in?	☐ Northland ☐ Auckland ☐ Manawatu
2 What are your initials?	
3 Are you:	☐ Male ☐ Female
4 Town where you live or nearest town:	
5 Do you have a mobile phone? *(To find you for follow-up questionnaires)*	☐ Yes ☐ No If Yes, what is your mobile phone number: _____
6 Do you have internet access? *Tick all that apply.*	☐ No ☐ Yes, at home ☐ Yes, at work ☐ Yes, mobile ☐ Yes, somewhere else If Yes, please provide your email address: _____
7 What is your **highest** completed qualification? *Tick one.*	☐ None ☐ School Certificate OR National Certificate level 1 OR NCEA level 1 ☐ Sixth Form Certificate OR National Certificate level 2 OR UE OR NCEA level 2 ☐ Higher School Certificate OR Higher Leaving Certificate OR University Bursary OR National Certificate Level 3 OR NCEA level 3 ☐ Bachelor's degree (e.g. BA, BSc) ☐ Diploma (not postgraduate) ☐ Master's degree (e.g. MA, MSc) ☐ PhD ☐ Trade or technical certificate (took more than 3 months study) ☐ Other. Specify _____
8 Which of these statements best describes your current work situation:	☐ Self-employed ☐ Working in paid employment ☐ Not in paid work, and looking for a job ☐ Not in paid work, and not looking for a job for any reason such as being retired, a homemaker, caregiver, or full-time student ☐ Other. Specify _____

9 Are you eligible for a Community Services Card?	☐ Yes ☐ No ☐ Don't know
10 Who lives in the same household as you? *Tick as many spaces as you need to show all the people living with you.*	☐ Partner (husband / wife / boyfriend / girlfriend) ☐ Mother / mother in-law ☐ Sister / brother ☐ Flatmate or boarder ☐ Father / father in-law ☐ Children / Partners children ☐ Other. Specify _____

11 What **medicines** are you on at the moment? You do not need to take this home, just do your best to remember and write the name of them. If you can't remember the name, what is the medicine for?

Name & Dose _____

Name & Dose _____

Name & Dose _____

Name & Dose _____

12 What vitamins, supplements, laxatives or protein drinks or other diet pills have you used in the last month? You do not need to take this home, just do your best to remember and write the name of them. If you can't remember the name, what is the product for?

Name & Dose _____

Name & Dose _____

Name & Dose _____

13 How often do you have a drink containing **added** sugar, including but not limited to chocolate milk, milo, soft drink, sports drinks, energy drinks, tea and coffee? *Don't include drinks with alcohol. Don't include 'diet' or 'zero' drinks that use artificial sweeteners instead of sugar.*	☐ Don't drink sugar sweetened drinks ☐ Once per week ☐ 2-3 times per week ☐ 4-5 times per week ☐ 1 a day ☐ 2-3 a day ☐ 4 or more a day
14 How much unflavoured water, including sparkling water, do you drink on a usual day?	☐ 0 – 250 mL ☐ 500-750 mL ☐ 1-1.5L ☐ 2 L or more 
15 During the last 7 days, please circle, on how many days did you eat fruit? *Please include all fresh, frozen, canned and stewed fruit. Do not include fruit juice or dried fruit.*	0-----1-----2-----3-----4-----5-----6-----7 ☐ Don't know
16 On average, please circle, how many servings of fruit did you eat each day? *A serving is 1 apple or 1 small banana or 2 mandarins or 2 kiwi fruit*	0-----1-----2-----3-----4-----5-----6-----7+
17 During the last 7 days, on how many days did you eat vegetables?	0-----1-----2-----3-----4-----5-----6-----7 ☐ Don't know
18 On average, how many servings of vegetables did you eat each day? *A serving is ½ - 1 cup carrots or salad or mixed vegetables*	0-----1-----2-----3-----4-----5-----6-----7+

19 How much margarine, butter or meat fat do you use to season vegetables or put on potatoes, bread or corn?	☐ 1 level teaspoon  ☐ 1 heaped teaspoon ☐ 1 tablespoon  ☐ 1 heaped tablespoon
20 How often do you choose low or reduced-fat varieties of food instead of the standard variety?	☐ Everyday ☐ 2-3 times per week ☐ 1-2 times per month ☐ Once per month or less
21 How often do you add salt to your food **after** it has been cooked or prepared?	0----------1----------2----------3----------4 Never Rarely Sometimes Often All the time

KA MAU TE WEHI awesome

During the last 7 days, how many times did you…	*Circle your answer:*
22 …eat fast food meals or snacks? e.g. hot chips, pizza, sausage roll, burger or chicken nuggets	0-----1-----2-----3-----4-----5-----6-----7
23 eat regular snack chips or crackers? e.g. ETA or Bluebird chips	0-----1-----2-----3-----4-----5-----6-----7
24 …eat desserts and other sweets? e.g. cake, puddings, lollies, chocolate or biscuits	0-----1-----2-----3-----4-----5-----6-----7
25 …eat lean meat? e.g. chicken thigh with no skin or unbattered fish or red meat with the fat trimmed	0-----1-----2-----3-----4-----5-----6-----7
26 …eat fresh seafood? e.g. fish, mussels or pipi	0-----1-----2-----3-----4-----5-----6-----7
27 …eat legumes? e.g. butter beans, chickpeas, hummus or lentils	0-----1-----2-----3-----4-----5-----6-----7
28 …have something to eat for breakfast? e.g. porridge or cereal with milk, yogurt with fresh fruit, eggs on toast, a muffin	0-----1-----2-----3-----4-----5-----6-----7
29 What did you have for breakfast this morning? *Write your answer here* ☛	

30 If you were given a choice, which of the following foods would you choose? *(Tick one on each line)*		
2 chicken drumsticks	1 chicken breast	
2 sausages	1 lamb shank	
4 slices of bread	2 rolls	
½ cup pasta or rice	1 cup pasta or rice	2 cups pasta or rice
1 kumara	2 potatoes	1 cup mashed potato
1 muffin	2 slices of cake	4 Gingernut biscuits

31 Tick the healthier way to cook from each pair:	
Deep fry	Stir-fry
Boiled	Uncooked / raw
Steamed	Boiled
Shallow fried	Roasted
Grilled	Pan fried

32 Which cooking method do you use the most at home?	
33 Which of the above cooking methods do you think is the healthiest of all?	
34 Which cooking method do you think is the <u>least</u> healthy of all?	
35 An example of an energy-dense food is: *Tick one*	☐ chocolate ice cream (290 calories per 1 cup) ☐ air-popped popcorn (30 calories per 1 cup) ☐ sliced fresh strawberries (50 calories per 1 cup) ☐ raw carrot sticks (50 calories per 1 cup)

36 Rank these foods, starting from 1 for the lowest number of calories. Calories are a measure of how much energy a food provides.

Write a number from 1 to 10 next to each food in this box:

____ Pint of beer 

____ Large 150g pack potato chips 

____ An apple 

____ An ice cream cone 

____ A pottle of yoghurt 

____ A glass of red wine 

____ Hot chips 

____ A small chocolate bar 

____ A cup of herb tea 

____ Flat white and muffin 

Write a number from 1 to 6 next to each food in this box:

____ Fish and chips 

____ Chicken stir-fry with rice 

____ Tuna salad 

____ A Bic Mac & Fries 

____ Beef stew with potatoes & vegetables 

____ A tomato, ham and lettuce sandwich 

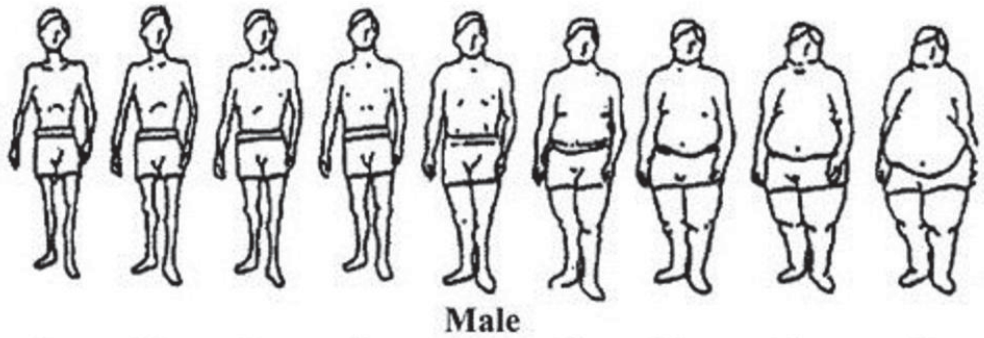
If you could eat one of these 6 meals now, which one would you choose? *Tick one of the above pictures.*

Thinking about the last 7 days:	*Tick or Circle your answer:*
37 Who in your household usually decides what food and drink is bought?	☐ Me ☐ Me and others jointly ☐ Someone else
38 Who in your household usually decides how meals will be cooked?	☐ Me ☐ Me and others jointly ☐ Someone else
39 Do you usually dish up your own meals or are your meals plated up for you?	☐ I dish up my own meals ☐ Somebody else usually dishes up my plate
40 If you work, do people at work eat lunch together?	0----------1----------2----------3----------4 Never Rarely Sometimes Often All the time ☐ Not applicable
41 Food runs out in my/our household.	0----------1----------2----------3----------4 Never Rarely Sometimes Often All the time ☐ Don't know
42 I/we make use of special food grants or food banks.	0----------1----------2----------3----------4 Never Rarely Sometimes Often All the time ☐ Don't know
43 I feel stressed because of not having enough money for food.	0----------1----------2----------3----------4 Never Rarely Sometimes Often All the time ☐ Don't know
44 The variety of food I am/we are able to eat is limited by a lack of money.	0----------1----------2----------3----------4 Never Rarely Sometimes Often All the time ☐ Don't know

45 I/we rely on others to provide food and/or money for food for my/our household when I/we don't have enough money.	0----------1----------2----------3----------4 Never Rarely Sometimes Often All the time ☐ Don't know
46 How often do you have a drink containing alcohol?	☐ Don't drink any alcohol ☛ Go to Q. 49 ☐ Never or rarely ☐ Less than monthly ☐ Once a month ☐ 2-3 times a month ☐ 1-2 times a week ☐ 3-4 times a week ☐ Once a day ☐ 2 times or more a day
47 How many drinks containing alcohol do you have on a typical day when you are drinking?	1-----2-----3-----4-----5-----6-----7-----8------9-----10-----11----12+ ☐ Don't know
48 During the past four weeks, how much of the time have you done less than you would like as a result of any emotional problems, such as feeling depressed or anxious?	0----------1----------2----------3----------4 None of the time A little the time Some of the time Most of the time All of the time ☐ Don't know

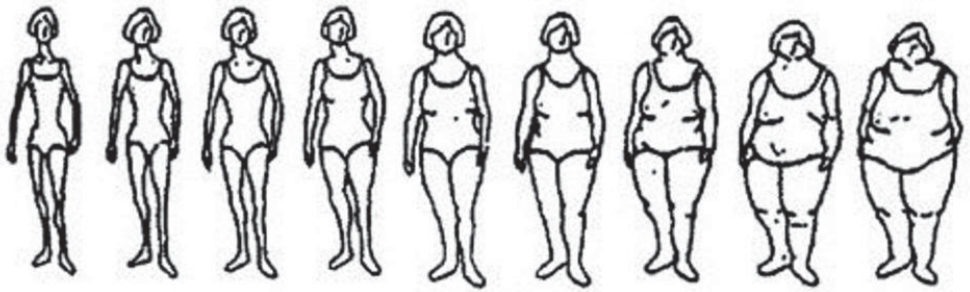
For questions 49 - 50 "activities" means doing anything using your muscles including activities you do at work, school, home, getting from place to place, for sport, recreation or leisure.	
49 During the last 7 days, on how many days did you do **moderate** physical activity that made you <u>breathe a little harder</u> than normal? *Think **only** about physical activities done for at least 10 minutes at a time.*	0-----1-----2-----3-----4-----5-----6-----7 ☐ Can't remember
49a What moderate physical activity did you do?	
49b How much time did you typically spend on each of those days doing moderate physical activity?	_____ hours (range 0-24) _____ minutes (range 0-60) ☐ Don't know
50 During the last 7 days, on how many days did you do **vigorous** physical activity that made you <u>breathe a lot harder</u> than normal (huff and puff)? *Think **only** about physical activities done for at least 10mins.*	0-----1-----2-----3-----4-----5-----6-----7 ☐ Can't remember
50a What vigorous physical activity did you do?	
50b How much time did you typically spend on each of those days doing vigorous physical activity?	_____ hours (range 0-24) _____ minutes (range 0-60) ☐ Don't know
51 During the last 7 days, usually how many hours sleep each night did you get?	Less than 5---- 5-----6-----7-----8-----9-----10+ ☐ Can't remember

52 Looking at the pictures below, please circle the ONE which you feel is most similar in size to you.



Male

1 2 3 4 5 6 7 8 9



Female

Q.53 Which, if any, of the pictures do you consider are:

(Write the numbers in the space provided)

_____ underweight

_____ neither under or over weight

_____ a little bit overweight

_____ a lot overweight

_____ seriously overweight

54 Are you **currently** on a weight loss programme or diet such as Weight Watchers, or a diet prescribed by a doctor or dietician?	☐ No ☐ Yes. Specify _____
55 In the **past** 12 months, have you used any of the following diets or weight loss programmes to try to lose weight (excluding the one you may currently be following)?	☐ Weight Watchers ☐ Jenny Craig ☐ The Paleo Diet ☐ Ketogenic Diet ☐ Dash Diet ☐ LCHF (low-carb high-fat) ☐ 5:2 Diet ☐ Church Challenge e.g. Aiga ☐ Other, please specify _____ ☐ Not applicable: I have not needed to lose weight in the past 12 months ☐ No. I don't feel I need to lose weight at the moment because: _____ ☐ No. I have wanted to lose weight but I haven't had been able to do a diet or programme because: _____ _____

Kia ora. Thank you. You have completed the questionnaire.
All completed questionnaires are to be returned to Dr Marewa Glover: M.Glover@massey.ac.nz