



# Public health evidence related to obesity in Tonga

## A literature review

April 2015



THE  
NOSSAL  
INSTITUTE  
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HEALTH

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## 1. Introduction

The prevalence of obesity in Tonga has increased over the recent decades, and is linked to a growing burden of non-communicable diseases, which are associated with considerable morbidity and premature mortality (1). Non-communicable diseases such as cancer, diabetes and heart disease also have significant social and economic consequences for families, communities and governments. Life expectancy in Tonga in 2006 was 72 years for women and 69 years for men; a more recent estimate from 2010 indicates a reduction in life expectancy to 69 years for women and 65 years for men, and this change is largely attributed to the increase in non-communicable diseases (2, 3).

A number of social and economic factors have contributed to the increase in obesity in Tonga: not only has there been increased food consumption and decreased physical activity, there have also been significant changes in the diet of Tongans linked to food importations from Western countries, reduced local production of traditional foods, rural-to-urban migration and concomitant increase in waged employment (and therefore expendable income) (4). However, even though Tonga is experiencing a number of economic and social transitions, people continue to observe traditional values, ceremonial practices and village lifestyles, and religion (Christianity) is central to people's lives – all factors that shape the nature of daily life, including eating patterns and participation in physical activity (5).

In 2009, the Government of Tonga developed a five year strategic plan to address the growing problem of non-communicable diseases (*Hala Fononga: Tonga National Strategy to Prevent and Control Non-Communicable Diseases 2010-2015*) (1). This plan identified and prioritised actions related to tobacco and alcohol use, healthy eating and physical activity. The purpose of the current review is to systematically identify and summarise all available public health evidence (from 2000 onwards) pertaining to obesity in Tonga to inform planning for the next five year strategic plan.

Public health evidence includes literature from epidemiological, socio-cultural and policy perspectives, as well as literature describing and evaluating interventions. The review aims to provide a comprehensive overview of:

- What is already known and understood about obesity in Tonga;
- What are the public health implications of what is known;
- What remains to be better known and understood.

The work is a product of the twinning program between the Nossal Institute for Global Health and the Ministry of Health, Health Promotion Unit, Tonga, and was funded by the Government of Australia.

## 2. Method

This report provides a comprehensive review of all available published and grey literature<sup>i</sup> pertaining to obesity in Tonga from a public health perspective, dating from 2000-2014, and undertaken in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for conducting systematic reviews (6), the details of which are described below.

### 2.1 Inclusion and exclusion criteria

Criteria for selecting articles that would be included in the literature review are as follows:

***Inclusion criteria:*** Any published or grey literature relating to obesity in Tonga from a public health perspective, published between 2000 and 2014 in English was included.

Given the purpose of the review and the relative absence of studies generating high-level evidence (i.e. evidence arising from randomised controlled trials), we included both published and grey literature that can be categorised as: quantitative and/or qualitative studies; review articles; and reports from government and non-government agencies.

***Exclusion criteria:*** Articles reporting on drug trials and bio-medical science research were excluded, as were articles in which the data pertained only to Tongans residing outside of Tonga, and multi-country studies that included Tonga but did not disaggregate the results by country.

### 2.2 Search strategy

The steps in the search strategy were as follows:

1. PubMed, Web of Science and Scopus electronic search engines were used to conduct an initial search for all relevant scientific publications using the following search terms:

- Tonga AND (obesity OR obese OR overweight).

A supplementary search was undertaken to ensure that all literature on diet and exercise factors relevant to obesity in Tonga were identified using the following search terms:

- Tonga AND (exercise OR physical activity OR diet OR nutrition OR food OR eat OR eating).

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<sup>i</sup> Grey literature refers to unpublished, non-peer reviewed sources of information such as monographs and reports

2. Additional articles were identified by scanning reference lists of publications identified by the search strategies outlined above.

3. Grey literature was obtained by searching the web using the Google Scholar search engine, and by consulting relevant personnel in the Tongan Ministry of Health.

### **2.3 Summary of included literature**

The initial search, conducted on 22 December 2014, identified 129 articles (PubMed = 43; Web of Science = 34; Scopus = 48). After removing duplicates, 56 articles remained. Twelve articles were excluded based on title and abstract, leaving 44 full-text articles to assess for eligibility. Five full-text articles were excluded; four because they were primarily commentary pieces that did not report any new data, and one because it was a multi-country study including Tonga, but the results were not disaggregated by country. A total of 39 articles from this initial search remained eligible for inclusion.

The supplementary search conducted on 16 January 2015 identified 164 articles (PubMed = 45 Web of Science = 82; Scopus = 31). After removing duplicates and articles already identified in the initial search, a total of 79 new articles were eligible for assessment. Seventy articles were excluded based on title and abstract, leaving nine full-text articles from the supplementary search to assess for eligibility. Three full-text articles were excluded because they were conference abstracts covering results reported in more detail in other previously identified articles. A total of six additional articles from the supplementary search remained eligible for inclusion, giving a total of 45 articles for review.

One additional peer-reviewed article found by searching reference lists of articles identified by the above searches was included, and ten grey literature reports were obtained, along with one relevant personal communication.

## **3. Results**

### **3.1 Epidemiology of obesity**

A total of 17 articles (14 published and three from grey literature) examining the epidemiology of obesity in Tonga since the year 2000 were identified and are summarized in Table 1. All studies assessed obesity using body mass index (BMI).<sup>ii</sup>

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<sup>ii</sup> BMI is a person's weight (in kilograms) divided by the square of their height (in metres). According to the WHO classification, the standard indicator for overweight is a BMI of  $\geq 25\text{kg/m}^2$  and a BMI of  $\geq 30\text{kg/m}^2$  is the standard indicator for obesity.

Additionally, obesity prevalence data provided by the Ministry of Health were supplied as a personal communication (7).

### **3.1.1 Prevalence of obesity**

Two studies used modelling techniques to estimate prevalence of overweight and obesity in Tonga over time, and both generated comparable estimates (8, 9). The most recent study was the Global Burden of Disease Study 2013 (8), which reported Tonga as one of the few countries in the world where the prevalence of obesity exceeds 50% in both male and female adults, and that the prevalence of obesity was higher in Tonga than in most comparable Pacific Island countries. Among adults aged 20 years or older, the proportion who were overweight or obese rose between 1980 and 2013 from 77.3% to 83.5% for men, and from 83.6% to 88.3% for women. The proportion who were obese rose between 1980 and 2013 from 43.7% to 52.4% for men, and from 59.5% to 67.2% for women (8).

Corresponding increases in obesity were modelled among Tongan youth. The Global Burden of Disease Study 2013 estimated that the proportion of youth aged 19 years or younger who were overweight or obese rose between 1980 and 2013 from 28.5% to 34.5% among boys, and from 43.1% to 52.6% among girls (8).

Comparably high levels of overweight and obesity among both adults and adolescents have also been documented in observational studies (10-22): the most notable being the Health Behaviour and Lifestyle of Pacific Youth study (2000-01) (18, 19); the Tonga STEPS survey in 2004 (10) and 2012 (22); and the Obesity Prevention in Communities Study (OPIC) study (2005-06) (23, 24) (Table 1). The most recent observational study was the Ministry of Health's 2012 STEPS survey that found 87.3% of men and 94.0% of women were overweight or obese (22), which was much the same as found in the STEPS survey in 2004 (89.2% men and 94.9% women were overweight or obese) (10).

Another recent Ministry of Health intervention included opportunistically screening people aged ≥30 years at health centres on Tongatapu, Ha'apai and Eua Islands for diabetes and hypertension. Among 2061 people (44% male, 56% female) screened in 2013-14, 84% of males and 87% of females were classified as either overweight or obese.(7)

### **3.1.2 Risk factors for obesity**

The most commonly identified demographic risk factors for obesity in Tonga are sex and age (dietary and physical activity risk factors are covered in Section 3.3). Tongan women and girls have consistently been found to have a higher average BMI and prevalence of obesity compared to Tongan men and boys. Epidemiological surveys revealed that the mean BMI in Tonga ranged from 32.6 to 34.9 for women,

compared with 30.2 to 31.7 for men (10, 13, 15-17). Across all studies in this review, the proportion of women who were obese ranged from 67.2% to 76.3%, compared with 49.4% to 60.7% for men (Table 1). Age was a risk factor for obesity in the national 2004 Tongan STEPS Study, which found the prevalence of obesity to be 68.7%, with the highest prevalence in the age group 35-44 years (77.3%) (10).

Behavioural risk factors for obesity have been investigated among Tongan youth; on average, more physically active youth have lower BMI scores (19, 23). In the OPIC study, youth who reported higher consumption of soft drinks and more time watching television had higher BMI scores (23), but this link was not found to be as strong in the Health Behaviour and Lifestyle of Pacific Youth study (19).

### **3.1.3 Validity of international BMI criteria for defining obesity in Tonga**

The above obesity prevalence estimates need to be interpreted with some caution as the validity of the standard BMI measurement to define overweight and obesity among people who are ethnically Polynesian is contested. Craig et al. (2001) (13) compared the body composition of Tongans with Australian Caucasians and found important differences that the authors argue challenge the validity of international obesity classification cut-off points for Tongans. The mean BMI was higher among Tongans (females 32.6kg/m<sup>2</sup>; males 30.3kg/m<sup>2</sup>) than Australians (females 25.8kg/m<sup>2</sup>; males 26.5kg/m<sup>2</sup>), and compared with Australians within the same BMI range, Tongans had significantly higher fat-free mass, elbow width, mid-arm muscle area and significantly lower %fat. The %fat at a BMI of 30kg/m<sup>2</sup> in Australian women was equivalent to the %fat found in Tongan women at 35.1kg/m<sup>2</sup>; a BMI of 30kg/m<sup>2</sup> in Australian men corresponded with 35.8kg/m<sup>2</sup> in Tongan men. Consequently, the authors argue that, for Tongan males and females, a BMI over 28kg/m<sup>2</sup> should be used to define overweight, and a BMI over 35kg/m<sup>2</sup> should be the cut-off for obesity (13).

However, it is important to note that this conclusion was based on a comparison of body composition alone. Further research is needed to examine health outcomes for Tongans across the different BMI ranges. For example, another study, also by Craig et al. (2007) (12) identified that the BMI cut-off points for predicting increased risk of type 2 diabetes mellitus, dyslipidaemia and hypertension were higher than the cut-off points for Caucasian and Asian populations: 29.3-31.7kg/m<sup>2</sup> in Tongan men and 34.0-35.0kg/m<sup>2</sup> in Tongan women.



**Table 1: Literature related to the epidemiology of obesity in Tonga since the year 2000**

Authors (year)	Study aim	Study design	Findings
Ng et al. (2014) (8)	The Global Burden of Disease Study 2013, which modelled estimates of overweight and obesity prevalence from 1980 to 2013	Utilised existing data from published and unpublished surveys to create models for prevalence of obesity.	<b>Overweight and obesity prevalence (adults):</b> The proportion of Tongan adults aged ≥20 years who were overweight or obese rose between 1980 and 2013 from 77.3% to 83.5% among men, and from 83.6% to 88.3% among women. The proportion of adults aged ≥20 years who were obese rose between 1980 and 2013 from 43.7% to 52.4% among men, and from 59.5% to 67.2% among women.  <b>Overweight and obesity prevalence (youth):</b> The proportion of youth aged 19 years or younger who were overweight or obese rose between 1980 and 2013 from 28.5% to 34.5% among boys, and from 43.1% to 52.6% among girls. The proportion of youth aged 19 years or younger who were obese rose between 1980 and 2013 from 6.5% to 8.3% among boys, and from 10.0% to 14.0% among girls.
Kingdom of Tonga (2014) (22)	2 <sup>nd</sup> round of the national STEPS survey undertaken in 2012 (first round was in 2004). The aim was to document the prevalence of trends in relation to NCDs and risk factors in Tonga	A total of 2599 people aged 25-64 years participated (response rate 89%), but women were over-represented (62.1%) compared with men (37.9%).	<b>Mean BMI:</b> The mean BMI for men was 31.3 kg/m <sup>2</sup> and for women was 34.8 kg/m <sup>2</sup> – these BMIs were already apparent in the 25-44 year old age group.  <b>Overweight and obesity prevalence:</b> Among those aged 25-64 years, the overall prevalence of overweight or obese was 90.7% (87.3% of men and 94.0% of women). By age 25-44 years, 89.9% were classified as overweight or obese, and 92.3% in the age group 45-64 years. The prevalence of obesity was 67.6% (57.2% of men and 77.6% of women).
Sluyter et al. (2013) (23)  Utter et al. (2008)(24)	Baseline data from the Obesity Prevention in Communities (OPIC) study.	Cross-sectional survey of youth aged 12-22 years from Tongatapu and Vava'u between 2005-06. Tongan participants were students recruited from schools in three districts on Tongatapu and all students on Vava'u. The average age was 15 years.	<b>Mean BMI:</b> The mean BMI in the Tongan sample was 22.4 kg/m <sup>2</sup> .  <b>Risk factors:</b> Increased TV watching, increased soft drink consumption and reduced levels of after-school physical activity were associated with higher BMI and total fat mass.

Stevens et al. (2012) (9)	Statistical modelling to estimate the prevalence of overweight and obesity from 1980 to 2008.	Utilised existing data from published and unpublished surveys.	<p><b>Overweight and obesity prevalence:</b> The estimated prevalence of overweight or obesity in Tonga increased between 1980 and 2008 from 56.7% to 86.0% among men, and from 58.1% to 90.7% among women. The estimated prevalence of obesity in Tonga increased between 1980 and 2008 from 17.6% to 49.4% among men, and from 26.3% to 70.4% among women.</p> <p><b>Mean BMI:</b> The overall mean BMI was 33.3kg/m<sup>2</sup> and the highest BMI (35.0kg/m<sup>2</sup>) was in the 35 to 44 year age group. Women had a statistically higher mean BMI (34.9kg/m<sup>2</sup>) than men (31.7kg/m<sup>2</sup>).</p> <p><b>Overweight and obesity prevalence:</b> Among those aged 25-64 years, the overall prevalence of overweight or obese was 92.1% (89.2% of men and 94.9% of women). By age 25-34 years, 89.6% were classified as overweight or obese, and 96.6% in the age group 35-44 years. The prevalence of obesity was 68.7% (60.7% of men and 76.3% of women) and was highest in the age group 35-44 years (77.3%).</p>
Ministry of Health and World Health Organization (2012) (10)	The Tonga STEPS Study; a cross-sectional household survey conducted in 2004 on Tongatapu, Vava'u and Ha'apai.	1,250 households were randomly selected, and one adult in each household was randomly selected to participate; the response rate was 80% yielding a sample size of 958 participants. Of these, 836 adults aged 25-64 years participated in physical measurements (including BMI).	<p><b>Overweight and obesity prevalence:</b> 38% females were overweight and 15% were obese. 21% of males were overweight and 7% were obese.</p>
Cacavas et al. (2011)(21)	To examine sources of food and dietary patterns of Tongan adolescents, and their perceptions of sociocultural influences on eating.	Linked to the OPIC study. A cross-sectional survey was undertaken among 2084 adolescents from 22 secondary schools on Tongatapu, and 6 secondary schools on Vava'u.	
Murayama et al. (2010) (14)	To determine trends in body physique among Tongan adults.	Longitudinal survey conducted between 1977 and 2001 in 'Uiha village (rural) and Kolofo'ou town (urban). Attempted census of adults aged 30-69 years. Response rates at each time point were very low and ranged between 9.8% and 41.9%. Sample size for each location at each time point was very low and ranged between 27 to 72.	<p><b>Mean BMI:</b> In 'Uiha village, the mean BMI rose between 1977 and 2001 from 28.0kg/m<sup>2</sup> to 31.0kg/m<sup>2</sup> among men, and from 30.6kg/m<sup>2</sup> to 33.3kg/m<sup>2</sup> among women. In Kolofo'ou town, the mean BMI rose between 1979 and 2001 from 30.7kg/m<sup>2</sup> to 31.4kg/m<sup>2</sup> among men, and from 34.6kg/m<sup>2</sup> to 36.1kg/m<sup>2</sup> among women.</p> <p><b>Obesity prevalence:</b> In 'Uiha village, obesity prevalence rose between 1977 and 2001 from 24.5% to 55.5% among men, and from 53.5% to 74.4% among women. In Kolofo'ou town, obesity prevalence among men was 52.1% in 1979 and 58.6% in 2001, and was 85.3% in 1979 and 78.5% in 2001 among women.</p>

<p>Craig et al. (2007) (12)</p> <p>Colagiuri et al. (2002) (11)</p>	<p>To evaluate different anthropomorphic cut-points as indicators of risk for type 2 diabetes mellitus, hypertension and dyslipidaemia.</p>	<p>A representative cross-sectional household survey on Tongatapu in 1998, and on Vava'u and Ha'apai in 2000. Multi-stage cluster sampling of participants aged &gt;15 years. The response rate was 80% in Tongatapu and 83% in Ha'apai yielding a total sample size of 1,024 participants, with 767 completing physical measurements (including BMI).</p>	<p><b>Mean BMI:</b> The mean BMI was 32.3kg/m<sup>2</sup>, and was higher in Vava'u/Ha'apai (33.2kg/m<sup>2</sup>) than in Tongatapu (31.6kg/m<sup>2</sup>).</p> <p><b>Obesity related risks:</b> Optimal BMI cut-points for predicting risk for type 2 diabetes mellitus, dyslipidaemia and hypertension were 29.3-31.7kg/m<sup>2</sup> in men and 34.0-35.0kg/m<sup>2</sup> in women.</p>
<p>Smith et al. (2007) (19)</p>	<p>Health Behaviour and Lifestyle of Pacific Youth (HBLPY) survey on Tongatapu, Vava'u and Hapa'ai in 2000.</p>	<p>A cluster random sample of primary and secondary students aged 10 to 20 years. Analysis of BMI measurements from a sub-sample of 443 students aged 11-16 years.</p>	<p><b>Mean BMI:</b> Mean BMI was 22.8kg/m<sup>2</sup> and was higher among girls than boys (23.7kg/m<sup>2</sup> vs 21.8kg/m<sup>2</sup>). There was a rapid increase in BMI of girls between 11-12 years and 15-16 years. BMI was higher among those whose parents had a white collar occupation.</p> <p><b>Overweight and obesity prevalence:</b> A total of 36.0% of boys and 53.8% of girls were overweight or obese according to international cut-off points (i.e. BMI ≥25 kg/m<sup>2</sup>), whereas 25.0% of boys and 37.6% of girls were classified in this way using higher Polynesian-specific cut-off points (i.e. BMI ≥26 kg/m<sup>2</sup>).</p> <p>A total of 7.5% of boys and 11.4% of girls were obese according to international cut-off points (i.e. BMI ≥30 kg/m<sup>2</sup>), whereas 4.0% of boys and 4.1% of girls were classified in this way using higher Polynesian-specific cut-off points (i.e. BMI ≥32 kg/m<sup>2</sup>).</p> <p><b>Risk factors:</b> 28.0% were classified as physically inactive during out-of-school hours, and physical activity was the only behavior independently associated with a lower risk of overweight or obesity. Neither poor diet nor increases in television watching were associated with a higher risk of overweight or obesity.</p>

Fukuyama et al. (2005) (20)	To assess age and sex differences in obesity prevalence in Tongan children and adolescents.	Cross-sectional survey of children and adolescents on Tongatapu between 2002 and 2003 and on Niuatoputapu in 2003. A convenience sample of 895 students aged 5-19 years recruited from elementary and high schools.	<p><b>Obesity prevalence:</b> The authors used International Obesity Task Force (IOTF) and Centres for Disease Control and Prevention (CDC) references for calculating obesity in child and adolescent populations.</p> <p><i>Obesity prevalence defined against IOTF references</i> For children aged 5-11 years living in Tongatapu and Niuatoputapu, the obesity prevalence was, respectively, 7.1% and 7.0% in girls and 2.6% and 2.1% in boys. For adolescents aged 12-19 years living in Tongatapu and Niuatoputapu, the obesity prevalence was, respectively, 19.4% and 6.0% in girls and 2.2% and 3.8% in boys.</p> <p><i>Obesity prevalence defined against CDC references</i> For children aged 5-11 years living in Tongatapu and Niuatoputapu, the obesity prevalence was, respectively, 10.1% and 10.5% in girls and 5.1% and 6.3% in boys. For adolescents aged 12-19 years living in Tongatapu and Niuatoputapu, the obesity prevalence was, respectively, 22.8% and 12.0% in girls and 2.2% and 3.8% in boys.</p> <p><b>Mean BMI:</b> In 1973, the mean BMI was 27.0kg/m<sup>2</sup> among men, and 28.3kg/m<sup>2</sup> among women. In 2000, this had increased to 30.2kg/m<sup>2</sup> among men, and 33.8kg/m<sup>2</sup> among women.</p> <p><b>Overweight and obesity prevalence:</b> In 2000, 84.0% of Tongan men and 92.8% of Tongan women were overweight or obese.</p>
Duarte et al. (2003) (15)  Duarte et al. (2003) (16)  Duarte et al. (2003) (17)	Cross-sectional survey on Tongatapu and on Vava'u and Ha'apai between 1998 and 2000. The BMI findings were compared with those of a 1973 survey among the same population.	Multi-stage cluster sampling of participants aged over 15 years, with a sample size of 1022 participants (~600 from Tongatapu and ~400 from Vava'u and Ha'apai)	<p><b>Mean BMI:</b> The mean BMI was 32.6kg/m<sup>2</sup> and 30.3kg/m<sup>2</sup> among female and male Tongans respectively, and 25.8kg/m<sup>2</sup> and 26.5kg/m<sup>2</sup> among female and male Australians respectively.</p> <p><b>Body composition:</b> Compared with Australians within the same BMI range, Tongans had significantly higher fat-free mass, elbow width, mid-arm muscle area and significantly lower %fat. The %fat at BMIs of 25kg/m<sup>2</sup> and 30kg/m<sup>2</sup> in Australian women was equivalent to the %fat found in Tongan women at</p>
Craig et al. (2001) (13)	Comparative study investigating body size and composition in Tongan and Australian Caucasian adults	A cross-sectional survey of 543 Tongans and 383 Australian Caucasians recruited using convenience sampling from villages on the main island groups in Tonga and from staff at a large Sydney hospital.	

				<p>28.8kg/m<sup>2</sup> and 35.1kg/m<sup>2</sup>, respectively; BMIs of 25kg/m<sup>2</sup> and 30kg/m<sup>2</sup> in Australian men corresponded with 27.5kg/m<sup>2</sup> and 35.8kg/m<sup>2</sup> in Tongan men.</p> <p>The authors suggest that BMI &gt;28kg/m<sup>2</sup> should be used to indicate overweight and &gt;35kg/m<sup>2</sup> to indicate obesity in Tongan females and males.</p> <p><b>Mean BMI:</b> The mean BMI was 24.1kg/m<sup>2</sup>.</p> <p><b>Overweight and obesity prevalence:</b> A higher proportion of girls (31.0%) than boys (21.0%) were overweight or obese, and similarly a higher proportion of girls (6.6%) than boys (3.3%) were obese.</p>
UNICEF (2001) (18)	Health Behaviour and Lifestyle of Pacific Youth (HBLPY) survey on Tongatapu, Vava'u and Hapa'ai in 2000.	A cluster random sample of 2,880 primary and secondary students aged 10 to 20 years. BMI measurements were taken from a sub-sample of 502 students.		

Note: BMI is a person's weight (in kilograms) divided by the square of their height (in metres). According to the WHO classification, the standard indicator for overweight is a BMI of  $\geq 25\text{kg/m}^2$  and a BMI of  $\geq 30\text{kg/m}^2$  is the standard indicator for obesity.

### 3.2 Sociocultural aspects of obesity

Socio-cultural factors influence beliefs, attitudes and behaviours in powerful and sometimes subtle ways. They shape conceptualisations of health and illness, food choices, patterns of eating and exercise, and preferred body size in all cultures. Eleven published articles reporting on socio-cultural aspects of obesity in Tonga were identified (Table 2) (5, 25-34). Seven of these articles relate to socio-cultural constructions of body image, which is discussed in Section 3.2.1.

Mavoa & McCabe (2008) highlight the ways in which social hierarchies based on seniority, sex, kinship, birth order and individual achievements influence food choices and distribution, eating patterns, physical activity and body size in Tonga (4). According to these authors, food is distributed on the basis of the relative rank and status of both the provider and the recipient. The best food and the most food are given to higher status individuals.

Tongan society is collectivist rather than individualistic in orientation. It is also very traditional and deeply religious and as such, the pressure for individuals to conform to commonly understood community expectations is high (4). In Tonga, the provision, preparation and consumption of food is very much a collective enterprise, integral to the social fabric (4). This is an important difference from Western settings where, to a much greater extent, individuals decide what food they will buy, prepare and consume, often with their weight and health in mind. Food plays a central role in most communal gatherings in Tonga: religious, political and social activities are frequently accompanied by an abundance of food. The plentiful provision of food and drink symbolises the worth of the hosts, their guests and the community. Even though events will be over-catered, guests are expected to consume as much food as possible (5).

(N)utritional advice disregards the degree to which abundance is culturally prescribed, for both the producer *and* the consumer. In addition to the pleasure and satisfaction it brings, eating is a culturally recognised way of both valuing a gift and the skill required to produce the food. To refuse to eat something – even on the basis of it being bad for one’s health – is profoundly rude and ungenerous. (p.299) (25)

Young (2002) argues from an anthropological perspective that health promotion messaging that simply transports Western models of health, illness, eating, food and body size to the Tongan context are doomed to fail because they do not take into account fundamental local understandings of these concepts (25). For example, many Western-influenced healthy eating campaigns model the relationship between food, eating and weight in purely physiological and mechanical terms i.e. food is fuel for the body, and if too much is consumed, it will be stored as fat, which will create problems for the body (illness). Food is understood as consisting of nutritional components (carbohydrates, fats, protein, minerals and vitamins), and diets are

designed to deliver these components to individual bodies. This model of the relationship between food, eating, weight, health and illness fails to take account of the deeply embedded meaning of food and eating in the daily lives of Tongans, and the important social and cultural functions they serve.

Food is used as a medium of exchange, to maintain good social relations (*tauhivaha'a*), to demonstrate social weight through physical weight, and to demonstrate male cultural competence. Food is the most frequently used medium of '*ofa* – generosity – and for ensuring people stay *va lelei* – on good terms with each other... Children are constantly being offered bits of food, and food often figures in the game of 'take and give' played between adults and toddlers, an early and significant lesson in generosity and reciprocity. Likewise, plates of food go back and forth between households on a daily basis (with an increased intensity on Sundays). (p.299) (25)

The values of respect, love and cooperation are central to Tongan culture, and are profoundly linked to the provision of food and eating, and consequently to body size. The values of love and cooperation are tangibly demonstrated by caring for others, and the provision of food is an important expression of caregiving (4). Food is fundamental to establishing and sustaining social connections. Food events help to build and nurture relationships between families and communities, and food is often central to ceremonial events (4). Consequently, a well-nourished (big) body is demonstrable proof that your family cares for you, and that you are socially well-connected. This is especially true for men.

(F)ood production serves to demonstrate that a man is fulfilling the duties of father, brother and son. Through over-production, men can publically demonstrate their (masculine) capabilities as farmers and/or fishers. Having enough food to give some away, whether as a sign of affection, in times of need, or by sponsoring a large community feast, also allows men to demonstrate their '*ofa* (generosity/love), and that they have been blessed, i.e., that they stand in good stead with the Creator. (p.299) (25)

Young (2002) also makes the point that uni-directional health promotion messaging that consist of "core to periphery, top to bottom, messenger to recipient style campaigns, in which the authority to decide what the message is rests with biomedical professionals, while the recipients are expected to listen and follow instructions, is impoverished" (p.296) (25). She maintains that there are distinct differences between 'health' as conceptualised by health promotion models, and 'health' as a lived cultural experience in a traditional conservative Tongan village. Consequently, health promotion campaigns that do not take account of local concepts of health and illness, and local meanings of food and eating are doomed to fail because they privilege biological processes over social relations (25). If health promotion strategies are to be successful they need to be more participatory than didactic, and engage with local communities taking account of the ways in which the concepts such as health and illness are culturally constructed, and social meanings of food, eating, exercise and body size.

### 3.2.1 Body image among youth

Most of the socio-cultural evidence in relation to obesity in Tonga describes cross-cultural comparisons of body image, particularly variations in valuing of different body sizes and body satisfaction among young people, and the body change strategies they pursue. Tongans of chiefly rank are expected to be larger than 'commoners' as large body size is proof of their ready access to high-status foods and less physically active (more regal) lifestyles. Large body size is traditionally seen as a sign of wealth, power and social status for both males and females, while thinness and weight loss suggest neglect and deprivation (25). Mavoa & McCabe (2008) also suggest that a larger body size among women indicates increased fertility and capacity to nourish children. Thin children tend to reflect poorly on their parents, who may be judged as negligent in their duty to provide for and nurture their children (4). However, the valuing of large body size is changing in some Pacific Island nations i.e. a smaller body size is being increasingly admired (4, 5, 33), and alongside this change is the development of increased body dissatisfaction and even eating disorders (30, 33), but the extent to which this is true for Tonga specifically is unknown.

Many of the studies related to body image in Tonga draw on the OPIC dataset, which used a mixed methods approach and was first reported on in 2009 (5, 29-33). For the OPIC study, McCabe and colleagues collected data pertaining to body satisfaction and the value attributed to different body sizes among 2489 adolescents from eight different countries (602 Australian; 628 Fijian; 614 Indo-Fijian; 333 Malaysian; 598 Tongan; 453 Tongans in New Zealand; 517 Chinese; 255 Chilean; and 641 Greek). They found that young people in Tonga consistently valued a larger body size for both men and women compared to those from other countries (33). Even though the Tongan adolescents (296 males, 302 females) had the second highest BMI in the OPIC study (the highest was among Tongans in New Zealand), their levels of body satisfaction were among the highest; and this was particularly the case for female Tongans.

Using the same dataset, McCabe et al. (2013) investigated the role of cultural values and religion on eating patterns and attitudes to body size by measuring and comparing cultural values and religious influence among Tongan, indigenous Fijian, Indo-Fijian and Australian adolescents (5). All Tongans in the study self-identified as Christian. The adolescents from Tonga were most likely to subscribe to the view that a large body size is linked to respect from the community and care from the family. Religion played a central role in determining the volume of food consumed in Tonga, particularly for males. The consumption of large amounts of food on special religious occasions is actively encouraged. Sharing food is a form of giving for people who may not be able to afford monetary contributions to their church (5).



McCabe and colleagues also interviewed 24 male and 24 female Tongan adolescents regarding preferred body size, body satisfaction and body change strategies. A number of papers have been published drawing on data from these interviews (27, 29, 31, 32). Although there were exceptions, for the most part these young Tongans liked big bodies, were relatively satisfied with their bodies, and were not aware of or concerned about their own weight, even though many were classified as being overweight or obese. They were more interested in their body shape, believing that males should be big and muscly with upper body strength as this increases their capacity to play sport and undertake heavy work. For this reason, many young men were engaging in exercise with the specific aim of developing muscles, not losing weight. In fact some young men believed that eating more food would help them to build muscles. By way of contrast, the ideal female body was judged to be round and soft: a thin or muscly female body was perceived to be unfeminine. Related to the relatively high levels of body satisfaction among Tongans reported by McCabe and colleagues, a KAPs study undertaken in 2012 by the Tongan Ministry of Health found that 49% of men and 69% of women judged themselves to be of normal weight, even though 87% of men and 94% of women were classified as overweight or obese (3, 22).

Cottino critiques and contests from an anthropological perspective, the claims of an 'obesity epidemic' in Tonga (34). She argues that people in Tonga have always valued larger bodies because being big projects to others that the person has access to wealth and power, and that they are well respected and well cared for – it is a source of esteem. This was exemplified historically by the body size of members of the royal family. Due to development, it is now possible for 'commoners' to access resources that allow them to also achieve larger bodies. Cottino maintains that the subsequent increase in the proportion of people who are classified as overweight or obese in Tonga can be constructed as the democratisation of larger bodies (and all that this signifies to the self and others about social position), rather than an obesity epidemic (which implies infectious causation). She also describes differences across generations in the extent to which a large body size is valued, with the younger generation preferring a body size somewhat smaller than the previous generation, but still larger than what health authorities define as desirable.

While socio-cultural factors are likely to be having a powerful influence on beliefs, attitudes, and patterns of food provision, food consumption, physical activity and body size, other environmental and economic factors are also important (as discussed in Section 3.4).

**Table 2: Literature related to socio-cultural aspects of obesity in Tonga since the year 2000**

Author/s (year)	Aim	Study design	Main findings
Cottino (2014) (34)	To investigate body weight in Tonga from a social and cultural perspective.	Ethnographic study undertaken in 2008-09 in the southern region of Tongatapu.	Cottino highlights the social construction of concepts such as 'overweight' 'obesity' and questions the validity of an 'obesity epidemic' in Tonga. She also draws attention to the contradictory policies that cause confusion for people in Tonga; on the one hand they are being urged to eat healthy foods and lose weight, while on the other hand the government enters into trade agreements that result in the importation of cheaply available processed junk foods.
McCabe et al. (2013)(5)	To compare the influence of culture and religion on eating patterns and attitudes to body size among adolescents from Australia, Fiji and Tonga	Cross-sectional survey with 628 Fijian, 463 Indo-Fijian, 598 Tongan and 534 Australian adolescents. Cultural values and religious influences assessed using Likert scale items.	Tongan adolescents were more likely to value larger body size, and religion influenced eating patterns, especially among males. The consumption of large amounts of food on special religious occasions is actively encouraged.
McCabe et al. (2012)(30)	To compare body dissatisfaction and the value of body size among adolescents from eight countries, including Tonga.	Cross-sectional survey of 2489 male and female adolescents, including 598 from Tonga.	Tongan adolescents had the second highest BMI (Tongans in NZ had the highest), valued larger body size, and had high levels of body satisfaction.
McCabe et al. (2011)(32)	To determine the impact of messages from family, peers and the media on body image among adolescent boys from Fiji (indigenous and Indo-Fijians), Tonga and Australia.	Qualitative interviews with 24 adolescent boys per cultural group asking body satisfaction, body ideal, body change strategies, and socio-cultural influences and messages.	The Tongan boys had the highest BMI. Tongan boys valued a large well-muscled body for health, and so they could play sport and do heavy work. For this reason many wanted bigger muscles for increased strength, and to achieve this they engaged in exercise to develop muscles. Family had a strong influence on body image, but the media did not.

Author/s (year)	Aim	Study design	Main findings
McCabe et al. (2011)(31)	This paper collates, summarises and compares findings from three studies that report on the socio-cultural factors influencing obesity among adolescents in Fiji, Tonga and Australia (but 3 <sup>rd</sup> study did not include Tongans).	<p>1. Qualitative interviews with 48 adolescents (24 male, 24 female) that enquired about patterns of eating, types and volumes of food consumed, physical activity, body satisfaction, body change strategies, and socio-cultural influences, physical activity and food</p> <p>2. Cross-sectional survey investigating body image, body change strategies, socio-cultural influences, physical activity, body satisfaction, and eating patterns among ~600 adolescents.</p>	<p>Both male and female Tongans valued a larger body size. Tongan males wanted to obtain a muscular body to improve sporting performance, increase strength and fitness, maintain health and perform physical work. They were influenced in this by family (esp fathers). Opportunities for females to engage in recreational activities were limited. Family and church/community influenced eating patterns, but media did not. The provision of food is seen as an expression of love, care and respect. The best food and the most food is given to higher status individuals. Even though Tongans had the highest BMI, they also had high levels of body satisfaction.</p>
McCabe et al. (2011)(29)	To compare body satisfaction and body change strategies among adolescent Tongans living in Tonga and adolescent Tongans living in New Zealand	Qualitative interviews with 24 adolescent boys and 24 adolescent girls living in Tonga, and the same number living in NZ, asking body satisfaction and body change strategies.	<p>There were no major differences between Tongans in Tonga and Tongans in NZ i.e. those in NZ had not internalised NZ values in relation to body size. There was a general lack of focus on body weight, and poor awareness of their own weight.</p> <p>Body shape was somewhat more important – overall a large body was valued.</p> <p>Body satisfaction was quite high – both males and females tended to judge their own body shape as optimal, regardless of how large or small they were. For males, a small body was associated with poor health, and a big well-muscled body was preferred – especially upper body strength (muscle shoulders and arms), which were considered useful for sport and work. Males who exercised would do so not to lose weight but to gain muscle, and some males believed that eating more will increase muscles. Females should be soft and round, not muscly – that would be unfeminine.</p>

Author/s (year)	Aim	Study design	Main findings
McCabe et al. (2009)(33)	To investigate the body image and body change strategies of adolescents from Fiji, Tonga and Australia.	Cross-sectional survey of 535 Australian, 628 Fijian, and 598 Tongan adolescents who completed measures of height, weight and body satisfaction.	The Tongan adolescents had the highest BMI. Males wanted a large, robust, muscular body, while females wanted a well-rounded soft, large body. Overweight adolescents were more dissatisfied with their bodies compared to those with normal weight. Females were more dissatisfied with their bodies than males. Tongans were more likely than any other group to engage in body change strategies to lose weight (females) or to increase weight and muscle (males). The social structure and hierarchical nature of Tongan society, and the world views, values and role expectations of people in Tonga profoundly and subtly shape patterns of food consumption, physical activity, and consequently body size.
Mavoa & McCabe (2008)(4)	To review literature between 1974 and 2007 pertaining to the socio-cultural factors influencing patterns of eating, physical activity and body size in Fiji and Tonga.	N/A	
Kirk et al. (2008)(28)	To investigate perceptions of body size among Tongan lay people and nurses, and their beliefs about the causes of obesity and its consequences for health.	A cross-sectional survey of 73 medical and surgical inpatients and out-patients and 34 nurses were asked their beliefs about obesity, perceptions of their own body size, and the health conditions associated with obesity. The BMI of all participants was recorded.	Nurses were younger and weighed less than the patient group, but both nurses and lay people underestimated their body weight. Only 10% of the lay group and 18% of nurses had a BMI <25 kg/m <sup>2</sup> , and 60% of the lay group and 32% of the nurses were obese. 42% of lay people and 53% of nurses were happy with their weight, including some obese participants. Overeating and lack of exercise were recognised as the cause of obesity. Awareness of the health consequences of obesity was higher among the nurses
Ricciardelli et al. (2007)(27)	To examine body image concerns in relation to muscularity among Fijian and Tongan male adolescents.	Qualitative interviews with 24 indigenous Fijian, 24 Indo-Fijian, and 24 Tongan adolescent boys. Questions focused on body size, weight, shape, satisfaction and change strategies.	The pursuit of muscularity was a dominant theme for many boys linked to attainment of strength and fitness, performance of sport and physical work, and health. Body change strategies included regulating food intake (both more and less) and exercise such as weight lifting, going to the gym, running and playing sports.

Author/s (year)	Aim	Study design	Main findings
Young (2002)(25)	Discusses the socio-cultural reinterpretations of imported health promotion messages based on Western concepts of health and illness.	N/A	Argues that health promotion messages are doomed to fail unless local concepts of health and illness and cultural meanings of food and physical activity are understood and taken into account when planning interventions. Involvement of local communities is essential.

### **3.3 Food, eating patterns and physical activity**

#### **3.3.1 Food and eating patterns**

The diet of many people in Tonga has rapidly evolved from a traditional low-fat diet based on locally produced complex carbohydrates, fish, fresh meat and leafy greens, towards increased consumption of imported refined starches, oils, fatty processed meats, tinned fish, sugar and confectionary, which means that energy-dense, nutrient-poor processed foods have significantly displaced traditional whole foods – often referred to as the ‘nutrition transition’(35-37).

Two papers reporting on foods consumed by adults (38, 39), three papers (from two studies) reporting on foods consumed by adolescents (19, 21, 40), and three papers reporting on an investigation of the relationship between preferred foods, perceived nutritional value and availability of foods, and food consumption patterns (35, 41, 42) were identified (Table 3). Additionally, eating patterns have been reported in a knowledge, attitudes and practices (KAPS) survey undertaken by the Ministry of Health in Tonga (3), in collaboration with the two rounds of the STEPS survey (10, 22), and another more recent survey was undertaken in schools by WHO (43).

A study undertaken in 2005-06 used a 24 hour food recall survey instituted across 14 days involving 15 men and 19 women from the village of Kolovai (16 kms from the capital). The three main sources of protein were fish, chicken and mutton; sources of fat were mutton, chicken and coconut; and sources of carbohydrates were banana, cassava and sugar. Imported foods accounted for half of participants’ energy and nutrient intakes, but much less for micronutrients. Local foods such as pork, kava and sea hare contributed significantly to micronutrient intake. One-third of energy intake was in the form of fat. The authors concluded that heavy reliance on imported foods may be contributing not only to obesity, but also to micronutrient deficiencies (38).

The Ministry of Health’s STEPS study of NCD risk factors, initially conducted in 2004 and repeated in 2012, found some improvements in relation to consumption of fruits and vegetables among 15-64 year olds. The proportion consuming less than the recommended five servings of fruit and/or vegetables each day in a typical week decreased from 92.2% in 2004 to 73.1% in 2012 (10, 22)

The first study among adolescents in Tonga was the Health Behaviour and Lifestyle of Pacific Youth (HBLPY) survey undertaken in 2000-01 (19, 40). Smith et al. (2006) examined eating patterns among a sub-set of 443 Tongan students from the HBLPY survey and found that that tinned mutton or beef was the food most often eaten daily – 57% reported consuming these foods daily, while less than half ate taro, fruit or vegetables at least daily. Soft drinks and sweets were consumed daily by approximately one-third. More girls than boys consumed sweets on a daily basis.

Students from Tongatapu had higher daily consumption of tinned mutton, beef and soft drinks, and lower daily consumption of taro or fruit compared with those from Vava'u and Hapa'ai (19).

Another study that collected information regarding food and eating patterns of adolescents was the Pacific Obesity Prevention in Communities (OPIC) project, which involved a cross-sectional survey among 2084 adolescents in 2005-06 (21, 24). This study found that the majority of young people sourced their breakfast from home, and their morning tea and lunch from the school canteen or nearby shops. The foods they consumed were mostly energy dense and nutrient poor. One-third of participants were frequent consumers of soft drink. Young women were more likely to be frequent consumers of packaged snacks and sweets (41% snack & 48% sweet) compared to young men (27% snack & 21% sweet). Participants were of the view that parents and schools encouraged healthy eating, but reported that the foods supplied in the school canteen were mostly unhealthy. The authors concluded that the school canteen would be a very strategic point of intervention to improve the diet of these young people (21, 24).

The Global School-based Health Survey (GSHS) initiated by WHO and other UN agencies with technical assistance from the Centers for Disease Control, Atlanta, was conducted in 2010. The goal of this survey to collect a range of health-related information from adolescents aged 13-15 years that could be used to inform the development and evaluation of youth health programs. A total of 2211 students from 24 schools in Tonga were recruited (51.6% male and 48.4% female) and surveyed using a self-administered anonymous questionnaire (43). The results of this survey indicate that, during the previous 30 days, 38.7% of students usually ate fruits and vegetables five or more times per day, and 56.3% drank carbonated soft drinks one or more times per day. Overall, 24.3% ate food from a fast food restaurant on three or more days during the past seven days.

Evans and colleagues (2001, 2002 & 2003) undertook a particularly interesting study in 2000 that used a list of 36 imported and traditional foods to investigate: people's preferred foods; how frequently they consumed these foods; and the perceived nutritional value and availability of the foods (35, 41, 42). The sample consisted of 425 Tongans (both males and females) from Tongatapu (n=385) and from outer islands (n=40). Participants were recruited from choir groups and were aged 12-82 years. It was found that the participants preferred healthier traditional, indigenously produced foods, and were reasonably accurate in their judgements regarding the nutritional value of both imported and traditional foods. The foods most preferred were fish, taro and indigenous chicken. The most nutritious were identified as fish, indigenous chicken and yams. The foods consumed at least weekly were cassava, bread, mutton flaps, taro greens, hibiscus greens, fish, yams, and imported chicken

parts. Generally speaking, the most preferred foods were eaten less than the less-preferred foods. Bread, mutton flaps and imported chicken parts were among the least preferred but most frequently consumed foods. While food consumption patterns did not strongly align with either preference or nutritional value, they were associated with the perceived availability of different foods. The high rate of consumption of imported foods occurred in spite of good knowledge about their lack of nutritional value. It was noted that more educated participants (as measured by a proxy variable of occupation), who were more commonly residing in the capital and integrated into the cash economy, were more likely to consume unhealthy imported foods, even though they had good levels of knowledge regarding the nutritional value of traditional vs imported foods.

The 2012 KAPS survey undertaken by the Ministry of Health also found that respondents had a very good knowledge of risk factors for non-communicable diseases, but cost was the most commonly identified influence on food purchasing patterns in this study (identified by 50%), not availability (identified by only 6%) (3).

### **3.3.2 Physical activity**

Physical activity in general and participation in sport in particular is highly gendered in Tonga. Women consistently report lower levels of physical activity compared with men (10). Young Tongan women are generally discouraged from engaging in unsupervised recreational physical activities away from their homes, and are expected to be dignified and restrained when they do (4). Participation in physical activity among females drops off with age, with a sharp decline once women have children (44). Three published papers (2, 19, 40) and four grey literature reports (3, 10, 22, 43) described findings from studies that collected information about physical activity among people in Tonga (Table 3)

Using a rapid assessment and response approach, Turk et al. (2013) investigated the poor uptake of physical activity by girls and women as a preliminary step to scaling up a netball program (2). Cultural attitudes inhibiting women's participation in physical activity included the expectation that women should be devoting their time to home and church. Concern about domestic violence for women who do not conform to this social 'ideal' was an issue for a few women. Some men thought it inappropriate for women to play sport in short skirts because other men might make derogatory, disapproving or sexual comments. A lack of essential amenities where women and girls can engage in physical activity, including team sports, was another barrier identified by participants (2). Facilitators of physical activity for women included the recognition of physical activity, especially team sports, as a positive social experience that is good for health. The authors suggested that endorsement of physical activity for women and girls by local religious and cultural leaders would provide 'permission' for women to engage in physical activity, and may help to



overcome social and cultural barriers that currently discourage women's participation (2).

The 2004 national STEPS survey investigated risk factors for non-communicable diseases. Almost half of the sample (43.9%) reported low levels of physical activity, more so women (54.8%) than men (32.4%) (10). This survey was repeated in 2012, and improvements in the proportion engaging in physical activity were noted with 23.7% reporting low levels of physical activity (15.1% of men, and 31.7% of women). However, most physical activity was work-related rather than for purposes of transport or recreational (22).

The Health Behaviour and Lifestyle of Pacific Youth survey undertaken in 2000-01 found that only 21% of Tongan adolescents exercised regularly, and 28% were sedentary (19). Girls were twice as likely to be sedentary compared to boys (36% vs 19%), as were older rather than younger adolescents (36% 15-16 year olds vs 24% 11-12 year olds). One-quarter watched TV for  $\geq 4$  hrs/day. The main variable associated with being overweight or obese was being sedentary. More recently, the 2010 GSHS found that 25.1% of 13-15 year olds were physically active for a total of 60 minutes per day on five or more days during the past seven days (43).

**Table 3: Literature related to the food and eating patterns and physical activity in Tonga since the year 2000**

Author/s (year)	Aim	Study design	Main findings
Turk et al. (2013)(2)	To identify stakeholder needs in relation to a netball communication strategy in Tonga, as well as describing the perceptions of barriers and benefits to participation in physical activity for women.	A rapid assessment and response (RAR) approach was used and involved interviews with 53 key informants and 65 FGD participants who were program beneficiaries. Questions investigated attitudes towards physical activity and chronic diseases, body image, self-efficacy and barriers and benefits of netball participation.	Barriers to physical activity for women included cultural factors, gender discrimination, socio-economic factors, stigmatising attitudes, threat of domestic violence, lack of infrastructure, and training issues. Facilitators of participation in physical activity included perceived social benefits, health benefits and career opportunities, and endorsement of local, religious and cultural leaders.
Tongan Ministry of Health, Kingdom of Tonga (2012) (3, 22)	2 <sup>nd</sup> round of the national STEPS survey undertaken in 2012 (first round was in 2004). The aim was to document the prevalence of trends in relation to NCDs and risk factors in Tonga, and to establish a baseline regarding population knowledge, attitudes and practices (KAPs) in relation to NCDs.	Cross-sectional survey among a total of 2599 people aged 25-64 years (response rate 89%), but women were over-represented (62.1%) compared with men (37.9%). Undertaken in urban and rural sites of Tongatapu, Vava'u, Ha'apai, 'Eua and Niuatoputapu. KAPS survey based on sub-sample of 2262.	Knowledge of NCDs and risk factors was overall good. Cost was most commonly identified as the most important factor influencing food purchasing patterns (identified by 50%). 73% ate less than five servings of fruit/vegetables daily. 16% did not eat any fruit/vegetables each day (males 18%, females 14%). 70% of men, but only 36% of women engaged in high levels of physical activity. 15% of men and 32% of women reported low levels of physical activity. Younger age groups engaged in more physical activity.
Ministry of Health and World Health Organisation (2012) (10)	The Tonga STEPS Study; a cross-sectional household survey conducted in 2004 on Tongatapu, Vava'u and Ha'apai.	1,250 households and one adult in each household were randomly selected to participate; response rate was 80% and sample size was 958 participants. 836 adults aged 25-64 years participated in physical measurements (including BMI).	43.9% reported a low level of physical activity (54.8% women, 32.4% men).

Author/s (year)	Aim	Study design	Main findings
WHO & CDC (2012) (43)	The goal of this survey to collect a range of health-related information from adolescents aged 13-15 years that could be used to inform the development and evaluation of youth health programs.	The Global School-based Health Survey (GSHS) recruited 2211 13-15 year old students from 24 schools in Tonga (51.6% male and 48.4% female) and surveyed them using a self-administered anonymous questionnaire.	<p>During the previous 30 days, 38.7% of students usually ate fruits and vegetables five or more times per day.</p> <p>More than half (56.3%) drank carbonated soft drinks one or more times per day.</p> <p>Overall, 24.3% had eaten food from a fast food restaurant on three or more days during the past seven days.</p> <p>One-quarter (25.1%) were physically active for a total of 60 minutes per day on five or more days during the past seven days.</p>
Konishi et al. (2011)(38)	To estimate energy and nutrient intake and food sources among Tongans.	A 24 hour recall survey for 14 days involving 15 men and 19 women in the village of Kolovai, 16 kms from Nuku'alofa. Imported foods included meats, canned foods, butter, flour, sugar. Local foods included seafood, plant staples, vegetables and coconuts.	<p>The three main sources of protein were fish, chicken and mutton; of fat were mutton, chicken and coconut, and of carbohydrate were banana, cassava and sugar.</p> <p>Imported foods accounted for half of participants' energy and nutrient intakes, but much less for micronutrients.</p> <p>Local foods such as pork, kava and sea hare contribute significantly to micronutrient intake.</p> <p>One-third of energy intake was in the form of fat.</p> <p>Heavy reliance on imported foods may be contributing not only to obesity but also to micronutrient deficiencies.</p>
Cacavas et al. (2011)(21)	To examine the sources of food and dietary patterns of Tongan adolescents, and their perceptions of sociocultural influences on eating.	Linked to the OPIC study. A cross-sectional survey was undertaken among 2084 adolescents from 22 secondary schools on Tongatapu, and 6 secondary schools on Vava'u. Semi-structured interviews were undertaken with 24 adolescent males and 24 females recruited from these schools.	<p>The majority sourced their breakfast from home, and their morning tea and lunch from the school canteen.</p> <p>The consumed foods were mostly energy dense and nutrient poor.</p> <p>One-third of participants were frequent consumers of soft drink. Young women were more likely to be frequent consumers of packaged snack and sweet food (41% snack &amp; 48% sweet) than young men (27% snack &amp; 21% sweet).</p> <p>Parents and schools encouraged healthy eating by adolescents, but the foods supplied in the school canteen were often unhealthy.</p>

Author/s (year)	Aim	Study design	Main findings
Smith et al. (2006)(19) Phongsavan et al. (2005)(40)	To assess overweight and obesity, diet and physical activity among adolescents in Tonga.	A cross-sectional survey was undertaken among 443 school students from Tongatapu, Vava'u and Hapa'ai, who had their height and weight recorded. They were asked about a range of health behaviours including food & drink consumption, physical activity and TV watching. A part of the Health Behaviour and Lifestyle of Pacific Youth (HBLPY) study.	Tinned mutton or beef was the food most often eaten daily – more than half consumed this daily. Over half did not eat taro, fruit or vegetables at least daily. Soft drinks and sweets were consumed daily by approximately one-third. More girls than boys consumed sweets on a daily basis. Students from Tongatapu had higher daily consumption of tinned mutton, beef and soft drinks, and lower daily consumption of taro or fruit. Regular physical activity outside of school was reported by only 21% of participants, and one-quarter were inactive outside of school, more so girls than boys, and more so older than younger adolescents. One-quarter watched TV for ≥4 hrs/day. The main variable associated with being overweight or obese was sedentariness – young and middle adolescents could benefit from targeted physical activity programs.
Kronen et al. (2004)(39)	To clarify whether the reduced intake of fresh fish and an increased consumption of canned fish are directly related to lifestyle disease risk in Tonga.	The ratio of fresh fish to tinned fish consumption was measured as a proxy indicator for lifestyle and dietary change, and obesity was measured as an indicator of lifestyle disease risk in 6 Tongan rural communities (n=362).	Consumption of fresh fish varied by village, but BMI was similar across villages. BMI was not associated with consumption of fresh or canned fish, but a higher BMI was associated with being female and being older.
Evans et al. (2001, 2002, 2003) (35, 41, 42)	To investigate the relationships b/t food preferences and perceptions of nutritional value and food availability, and food consumption patterns.	Cross-sectional survey of 425 Tongans eliciting information regarding: preferences, frequency of consumption, perception of nutritional value, and availability for 36 traditional and imported foods.	Participants preferred traditional foods and accurately perceived these as more nutritious. The foods consumed at least weekly were cassava, bread, mutton flaps, taro greens, hibiscus greens, fish, yams, and imported chicken parts. The most preferred foods were fish, taro and indigenous chicken. The most nutritious were identified as fish, indigenous chicken and yams. The most preferred foods were eaten less than the less-preferred foods. Bread, mutton flaps and imported chicken parts were among the least preferred but most frequently consumed foods – indicating that preference has little to do with consumption patterns. Consumption patterns did not coincide with preference or nutritional value, but were related to perceived availability of different foods.

### 3.4 Global and economic influences

Four articles that discuss global and economic factors contributing to the increase in obesity in Tonga were identified (Table 4). The 'nutrition transition' that has taken place in many Pacific Island countries over the last two to three decades is implicated in the rise of obesity, which in turn is a major risk factor for the 'health transition' i.e. the increase in non-communicable diseases. Several authors argue that the growth in these diseases is directly linked to changes in international trade relations between Pacific Island countries such as Tonga and other (mainly Western) countries (35-37, 41, 42). The transformation in patterns of food procurement, preparation and consumption are largely attributed to outside influences brought to Tonga by colonisation, globalisation, modernisation of transportation and communications, and the consequent opening up of trade routes resulting in growth of a cash economy, urbanisation and out-migration, along with large-scale availability of imported processed foods, and reduced production of traditional healthier foods.

In the case of Tonga, commonly imported foods include processed high-fat meats (mutton flaps, turkey tails, chicken parts, corned beef), tinned fish, palm oil, sugar, flour, soft drinks and packaged snacks and confectionary. These foods have to a significant extent replaced fresh sea-foods and meats, and locally grown root vegetables and fruits (36, 37). The main trading partners of Tonga are New Zealand and the US, who have been accused of 'dumping' food that is often not marketable for consumption in their own countries. The per capita consumption of high fat imported meats in Tonga increased by over 60% between 1989 and 1999, from approximately 35 kgs per person to 56 kgs per person (42). Food importation on a large scale displaces the production of local foods, with the result that the infrastructure, skills and knowledge required to grow and market food are gradually lost. Reduction in the local production of food is inversely related to a growing dependence on imported processed foods, which has obvious implications not only for obesity and chronic diseases, but also for food security in Tonga (42).

The work of Evans and colleagues (2001, 2002 & 2003) (described in Section 3.3.1 above) highlighted the fact that imported foods are often cheaper, more available and more accessible than traditional foods, and it is these factors that influence food consumption patterns more than food preferences and knowledge about nutritional value (35, 41, 42). They concluded that campaigns providing information about the nutritional value of different foods are unlikely to be successful unless they are accompanied by economic reforms designed to reduce dependence on and consumption of unhealthy imported foods, and to increase the sustainable production of locally grown traditional foods, including seafood. Cottino also highlights the ways in which some Tongan Government policies contradict each

other, and how they probably need to be reconciled if people in Tonga are expected to lose weight.

(T)here is confusion among the population due to concomitance of messages conveyed by the local policies: on the one side, biomedical messages inviting the population to lose weight and eat healthy, and on the other side a wide accessibility to junk and processed tinned food, imported in big quantities, thanks to trade agreements with the first world.  
(p.82) (34)

Economic policy reforms that aim to reduce access to these unhealthy imported foods are likely to have popular support as suggested by the findings from the Ministry of Health's 2012 KAPs survey in which 95% of respondents agreed that the availability of unhealthy/fatty foods should be regulated by law(3).

**Table 4: Literature related to global and economic influences on obesity in Tonga since the year 2000**

Author/s (year)	Aim	Study design	Main findings
Estime et al. (2014) (37)	To generate profiles of food consumption and expenditure patterns in five Pacific countries; and highlight the main 'unhealthy' food imports to inform policy making.	Secondary analysis drawing on two existing datasets: 1. Obesity rates as reported by WHO and 2. Aggregated household level food expenditure and consumption from the Household Income and Expenditure Survey, to examine the links between trade, diets and NCDs (using obesity as an indicator).	Of food expenditure in Tonga: 52% was for imported food (2 <sup>nd</sup> highest of five Pacific countries); 42% was for unhealthy food (highest of five countries); 34% of expenditure was for processed food (highest of five countries); 54% was for non-traditional food (highest of five countries). A (non-significant) association between imported foods and obesity prevalence. Mutton, poultry and cooked meat were the most commonly purchased imported foods in Tonga. The authors conclude that trade is a structural driver of NCD risk factors such as obesity, and suggest that imported foods could be targeted with policy changes to improve health outcomes.
Evans et al. (2001, 2002, 2003) (35, 41, 42)	To examine why imported foods are being increasingly consumed instead of traditional foods by investigating the relationships b/t food preferences and perceptions of nutritional value and food availability, and food consumption patterns.	Cross-sectional survey of 425 Tongans eliciting information regarding: preferences, frequency of consumption, perception of nutritional value, and availability for 36 traditional and imported foods.	Policy to reduce chronic disease should address the linkages b/t economic development and health, and promote availability and cost-competitiveness of healthier, traditional foods.

### **3.5 Obesity-related interventions**

There have been two major obesity prevention interventions in Tonga, one targeting adolescents (aged 12-18 years) known as the Ma'alahi Youth Project (MYP), and the other targeting women aged 15-45 years, known as Kau Mai Tonga Ke Tau Netipolo (KMT). Both of these interventions have been comprehensively described and evaluated – the former intervention met with limited success in achieving its goals (reduced BMI and improved health behaviours among adolescents), while the latter intervention has been extremely successful (increased engagement in physical activity for women). The key literature and findings related to the evaluation of the MYP and KMT projects/campaigns are presented in Table 5.

#### **3.5.1 Ma'alahi Youth Project**

The Ma'alahi Youth Project (MYP) was a product of the Obesity Prevention in Communities (OPIC) project, which was undertaken between 2004 and 2009 in four countries, Australia, New Zealand, Fiji and Tonga. The primary aim of the OPIC project was to determine the effectiveness of a whole-of community intervention program for obesity prevention in youth using a quasi-experimental study design with intervention and comparison groups. The premise under-pinning the project was that increasing community capacity would influence changes in the local environment as well as individual knowledge and attitudes in ways that would facilitate improvements in eating patterns and physical activity, and consequently reduce the prevalence of obesity (45). In Tonga, school students from three districts of the main island, Tongatapu, comprised the intervention group, and all students of the same age from the island of Vava'u comprised the comparison group. A cohort of young people (n=1083 in the intervention group, n=1396 in the comparison group) were followed, and the mean duration between pre and post data collection points was 2.5 years (45-47).

Initial interviews with young people provided information regarding socio-cultural influences relevant to obesity prevention, and community participation informed the design of actions plans for a comprehensive, community-driven, intervention program (48). The MYP in Tonga aimed to address unhealthy eating patterns and low levels of physical activity by targeting interventions at both village and school level. The MYP action plan consisted of ten points that guided program development: capacity building; social marketing; evaluation; promoting healthy breakfast, school lunches, fruits and vegetables, and water consumption; increased organised sport and informal physical activities; and using role models as champions for the program (47, 49). The primary outcome measures were changes in anthropometry and body composition, and the secondary outcome measures were changes in behaviours, knowledge, quality of life, body size perceptions and community capacity.



However, despite the comprehensive design of the MYP, the results were disappointing. At follow-up, the intervention group had statistically significantly less body fat than the comparison group, but there was no significant difference in weight, BMI or prevalence of overweight/obesity (50). The combined prevalence of overweight and obesity increased substantially over the follow-up period in both intervention and comparison groups (approximately 11 percentage points), with intervention and comparison male adolescents increasing by +3.2 and +7.7 percentage points, and female adolescents by +19.9 and +13.1 percentage points, respectively (50), indicating that males benefited more from the intervention than females. There were no overall improvements in eating patterns or levels of physical activity when the intervention and comparison groups were compared (50).

The authors identified possible explanations for these results including: insufficient time frame for the intervention to have an effect due to a longer than anticipated establishment phase; the intensity of the intervention may have been insufficient; concurrent policy-based interventions that supported obesity reduction were minimal; and socio-cultural factors were not adequately considered when designing the interventions and their influence under-estimated. The relatively lower levels of weight gain among male adolescents highlighted the difference gender makes; this needs to be taken into account when planning strategies for obesity prevention – it may be the case that males and females require different strategies. The authors make the point that interventions targeting social groupings (families, schools and churches) may be more effective than those that depend on individual behaviour change. They also emphasise the need to address the problem of obesity using a multi-pronged approach that engages government leaders to implement policies across different sectors, and community leaders to role model and influence practices (50). The development and implementation of policies relating to food and physical activity are needed e.g. school food and physical education policies, provision of outdoor spaces that are safe and suitable for physical activity, and food importing and pricing policies (50).

A number of lessons have been learned from the OPIC / MYP intervention study. Firstly, it is very important to identify socio-cultural factors that influence what adolescents eat and how active they are, before designing the details of the intervention. When undertaking school-based programs, full commitment of the school leadership and teachers is necessary if it is to be successful. If the program is perceived by the school staff as not really necessary, an additional burden in terms of workload, or an intrusion into the existing school curriculum, the chances of positive outcomes are reduced. The ambition of the intervention has to be realistically aligned with the local capacity and desire to engage with the intensity of the activities. Similarly, it is important to consider local capacity to design, implement and evaluate programs, and the human resources available for this.

Programs that are a direct response to demands from the community are much more likely to be successful. While interventions to prevent obesity through community participation can produce some positive effects regarding diet and levels of physical activity, it is also necessary to consider the health impacts of policies from a range of related sectors to ensure that they are health promoting (51, 52). For example, by altering the environment in which people live and work, multi-sectoral policy action has the potential to improve health by, for example, developing infrastructure that encourages physical activity, and introducing regulations that increase the availability of healthier foods and reduce access to unhealthy foods.

### **3.5.2 Kau Mai Tonga Ke Tau Netipolo**

Kau Mai Tonga Ke Tau Netipolo (Come on Tonga! Let's Play Netball – KMT) is an initiative developed and initially implemented in June 2012 through a partnership between the Government of Tonga, the Australian Government's Australian Sports Outreach Program, and Netball Australia. The program is delivered through Tonga's Ministry of Health (Health Promotion Unit) and Ministry of Internal Affairs (Sports Division) in collaboration with the Tongan Netball Association. The KMT program was carefully planned, multi-pronged, and well evaluated. The primary goal of KMT is to increase the level of physical activity among women and girls aged between 15 and 45 years, recognising that women are much less likely than men to partake in physical activity for a range of socio-cultural reasons (discussed in Section 3.3.2) (53, 54). While the promotion of netball was an integral component of the campaign (as indicated by its name), the main purpose was to increase women's engagement in physical activity more broadly. Initial research to investigate the barriers to and facilitators of women's participation in physical activity was undertaken and used to inform the design of the program (2). KMT employed a range of strategies and media to change community attitudes regarding women's participation in physical activity, to raise awareness of the negative health consequences of sedentary lifestyles and the importance of physical activity for women, as well as facilitating a large network of netball teams that trained and competed together (53-55). It was implemented using annual intensive media campaigns that were timed to coincide with the lead up to the national netball tournament: the first was June-July 2012, the second from May-June 2013, and the final phase was implemented in 2014. Additionally, community activities designed to increase physical activity for women were maintained across the year. A range of quantitative and qualitative evaluations of the KMT initiative have been conducted, and those pertaining to 2012 and 2013 are available and therefore included in this review (56-58).

#### ***Qualitative evaluation December 2012***

A qualitative evaluation conducted in 2012 investigated the extent to which KMT was contributing to healthy behaviours, social inclusion and social cohesion. Semi-

structured in-depth interviews were conducted with 16 key informants and longitudinal case studies were undertaken with 30 participants from communities across Tonga (57). The author of this study concluded that the KMT program successfully raised awareness of the health-related benefits of physical activity, and generated a strong demand for netball. Women reported engaging in more physical activity following the implementation of KMT, which provided opportunities for girls to play sport after school, and for older women to engage in sport as a distraction from their daily household activities. This helped them to become more active and fitter. They slept less during the day, and were therefore more able to do their household chores. Some of the women reported that they had reduced tobacco and alcohol use, and made dietary changes such as eating less junk food and not consuming soft drinks, and some had lost weight after participating in KMT. Despite initial indications of socio-cultural disapproval of women's participation in recreational physical activity, endorsement of women joining netball teams was widespread. Families and communities actively supported women's engagement in the netball program by coming along to watch them play, catering for games, and providing childcare and transport to games. At the individual level, many women appreciated the social benefits of being a team member, and described how KMT had improved their motivation, confidence and leadership skills. Many highlighted how KMT had helped to strengthen their communities, because it brought together groups of women for a common purpose who previously did not have a specific reason for coming together (57).

### ***Quantitative evaluation Wave 1***

The 2012 KMT campaign was active in June-July, and the research to evaluate the effectiveness of the campaign was undertaken in October-November 2012. This involved recruiting a nationally representative sample of women aged 15-45 years (n=1192) who were asked about changes in knowledge, attitudes and behaviours in relation to participation in physical activity, netball in particular (56). Forty percent of these women reported having participated in recreational physical activity on three or more days of the previous week. One-third of the sample (33%) had met or exceeded the recommendation that they partake in physical activity for 30 minutes or more on three or more days a week. Overall, 58% had engaged in some physical activity in the previous week, but 42% had not participated in any physical activity at all, indicating that a substantial proportion of women were still risking the negative health effects of inactivity. Physical activity levels were consistent across age groups (56).

A large majority thought that physical activity was useful (93%), healthy (91%) and good (90%). Fewer endorsed physical activity as enjoyable (81%) and pleasant (72%), perhaps indicating that women are inclined to perceive physical activity as

something they should do rather than something they would like to do, and that future campaigns should focus less on the health benefits of physical activity (which women already recognise) and more on the potential for enjoyment (56).

The women reported strong positive attitudes regarding participation in physical activity. Nearly 90% strongly agreed that they wanted to exercise regularly. Awareness of the health risks associated with physical inactivity was quite high, and increased with age. Those who were more active tended to have better knowledge of health risks. The authors recommended that future campaigns should focus on both the benefits of participating in physical activity and the risks of inactivity. However, there was an apparent reduction in participation in physical activity when respondents were asked if they were currently doing more physical activity than four months previously. While 29% reported doing more physical activity, 41% said they were doing less. It is relevant to note that this survey was conducted during the off-season for netball, and four months previously was during the netball season. This may explain the drop in physical activity for such a large proportion of respondents (56).

The survey also assessed the reach of the KMT campaign, which seems to have been extensive. Over 90% of respondents were aware of the campaign, mainly through television (74%), radio (54%) and billboards (45%). Almost all respondents (93%) indicated that the campaign led them to 'think about being more active', 84% considered engaging in some form of physical activity as a result of the campaign, and 66% reported looking into playing netball specifically (56).

The fact that only 27 netball teams registered to compete in Tonga's tournament before the implementation of KMT, but 370 teams (involving about 3,000 women) registered following KMT is a strong indicator of the program's success in 2012 (55). However, the popularity of the program became a problem because the tournament organisers were ill-prepared for the large number of teams expecting to compete in the tournament. Another issue needing to be addressed is the seasonality of netball – it is not clear how best to sustain women's participation in physical activity outside of the netball season. Building the organisational capacity of the Tongan netball association to make netball available year-round across Tonga would ensure that the considerable momentum and interest generated by the KMT program is not lost (57).

### ***Quantitative evaluation Wave 1 vs Wave 2***

The 2013 KMT campaign was active in May-June, and the research to evaluate the effectiveness of the campaign was undertaken in August-September 2013. The Wave 2 evaluation involved 1205 women aged 15-45 years. There were several differences in the design of the Wave 1 evaluation and the Wave 2 evaluation in terms of islands

and districts sampled, and time elapsed since the KMT campaign (12 weeks for Wave 1 and six weeks for Wave 2). This means that comparisons between the two waves should be interpreted with caution. Additionally, it should be noted that the analysis of the two waves of survey data were undertaken by different research groups, and the Wave 1 proportions reported in the Wave 2 report differ slightly from those reported in the Wave 1 report (perhaps because they were weighted in the Wave 2 report) (58).

Less than one-third of Wave 2 respondents (29.2%) had participated in physical activity on three or more days during the preceding week, and 49.4% had not engaged in any physical activity at all. The women from the Wave 1 survey were more likely to have participated in physical activity on three or more days in the previous week than women from Wave 2 (38.5% *cf* 29.2%), and women from Wave 2 were more likely than women from Wave 1 to have been inactive during the previous week (49.4% *cf* 43.1%). This reduction in the proportion participating in physical activity among women in the Wave 2 survey relative to women in the Wave 1 survey was particularly evident for women aged  $\geq 35$  years, married women, and women with less education. Similarly, women in the Wave 2 survey were less likely than the women in the Wave 1 survey to have played netball in the last week, and compared to four months previously. This was despite the fact that the time between the KMT campaign and the survey was longer in Wave 1 than Wave 2 i.e. it would be expected that the impact of the campaign would be weaker for Wave 1 respondents. According to the authors of the Wave 2 report, this indicates that the 2013 KMT campaign had less impact than the 2012 campaign (58).

By way of contrast, the women in the Wave 2 survey had a much more positive attitude towards regular participation in physical activity compared with the women from Wave 1. The Wave 2 women were much more likely to find participation in physical activity pleasant, enjoyable, healthy and good, than the Wave 1 women. The Wave 2 women were also more likely than the women from Wave 1 to perceive that significant others in their lives would approve of their participation in regular physical activity, and that they were capable of participating in regular physical activity. This is good evidence that women's awareness of the need to be physically active had shifted substantially, but it also raises the obvious question as to why these improved attitudes among Wave 2 women did not translate into better uptake of physical activity compared to Wave 1 women (58). Some follow-up qualitative investigation may have shed light on this issue.

When the impact of the Wave 1 and Wave 2 campaigns were compared, there were no major differences in terms of the extent to which the campaign made women stop and think about physical activity, the degree to which the campaign provided new information, and the degree to which the campaign made them concerned

about the negative health effects of inactivity. However, the Wave 2 women compared with the Wave 1 women were less inclined to talk with others about the campaign, persuade others to be more physically active, look for ways to play netball, or to feel encouraged to engage in other forms of physical activity. Awareness of the link between physical activity and a range of health conditions (diabetes, obesity, heart disease, cancer and stroke) was better among the Wave 2 women compared with the Wave 1 women. This was particularly the case for younger women (58).

In summary, the KMT initiative does seem to have contributed to substantial improvements in awareness regarding the importance of physical activity for women, women's willingness to participate in physical activity, and community acceptance of women being physically active. All of these factors are essential precursors of behaviour change, which invariably takes time to achieve. The lower levels of participation in physical activity in 2013 compared with 2012 warrant further investigation, but may be because the novelty of the initiative and the freshness of the messages in 2012 generated more interest and activity than in 2013. It will be interesting to examine this trend in light of the evaluation of the 2014 campaign when those data become available.

**Table 5 Literature related to the evaluation of the Ma'alahi Youth Project (MYP) and Kau Mai Tonga Ke Tau Netipolo (KMT) since the year 2000**

Author/s (year)	Aim	Study design	Main findings
Newton & Newton (2014) (58)	To evaluate the effectiveness of the 2013 (Wave 2) KMT campaign.	The Wave 2 evaluation recruited a nationally representative sample of women aged 15-45 years (n=1205) who were asked about changes in knowledge, attitudes and behaviours in relation to participation in physical activity, netball in particular.	<p>The 2013 KMT campaign had less impact than the 2012 campaign. The women from the Wave 1 survey were more likely to have participated in physical activity on three or more days in the previous week than women from Wave 2 (38.5% <i>cf</i> 29.2%), and women from Wave 2 were more likely than women from Wave 1 to have been inactive during the previous week (49.4% <i>cf</i> 43.1%). Similarly, women in the Wave 2 survey were less likely than the women in the Wave 1 survey to have played netball in the last week, and compared to four months previously.</p> <p>Further, the Wave 2 women compared with the Wave 1 women were less inclined to talk with others about the campaign, persuade others to be more physically active, look for ways to play netball, or to feel encouraged to engage in other forms of physical activity.</p> <p>By way of contrast, the women in the Wave 2 survey had a much more positive attitude towards regular participation in physical activity compared with the women from Wave 1. The Wave 2 women were much more likely to find participation in physical activity pleasant, enjoyable, healthy and good, than the Wave 1 women.</p> <p>Additionally, awareness of the link between physical activity and a range of health conditions (diabetes, obesity, heart disease, cancer and stroke) was better among the Wave 2 women compared with the Wave 1 women. This was particularly the case for younger women.</p>
Parr et al. (2013) (59)	To evaluate the effectiveness of the 2012 KMT campaign.	Nationally representative sample of women aged 15-45 years (n=1192) asked about changes in knowledge, attitudes and behaviours in relation to participation in physical activity.	<p>Over 90% of respondents were aware of the campaign.</p> <p>Almost all respondents (93%) indicated that the campaign led them to 'think about being more active', 84% considered engaging in some form of physical activity as a result of the campaign, and 66% reported looking into playing</p>

Author/s (year)	Aim	Study design	Main findings
			<p>netball specifically.</p> <p>One-third of the sample (33%) had met or exceeded the recommendation that they partake in physical activity for 30 minutes or more on three or more days a week. However, 42% had not participated in any physical activity at all.</p> <p>Awareness of the health risks associated with physical inactivity was high, and increased with age. A large majority thought that physical activity was useful (93%), healthy (91%) and good (90%), and nearly 90% strongly agreed that they wanted to exercise regularly. However, fewer endorsed physical activity as enjoyable (81%) and pleasant (72%).</p> <p>There was an apparent reduction in participation in physical activity when respondents were asked if they were currently doing more physical activity than four months previously. While 29% reported doing more physical activity, 41% said they were doing less. It is relevant to note that this survey was conducted during the off-season for netball, and four months previously was during the netball season. This may explain the drop in physical activity for such a large proportion of respondents.</p>
Sustineo (2013) (57)	A qualitative evaluation conducted in 2012 to investigate the extent to which the KMT campaign contributed to healthy behaviours, social inclusion and social cohesion.	Semi-structured in-depth interviews were conducted with 16 key informants and longitudinal case studies were undertaken with 30 participants from communities across Tonga.	<p>Women reported engaging in more physical activity following the implementation of KMT.</p> <p>Some reported that they had reduced tobacco and alcohol use, and made dietary changes such as eating less junk food and not consuming soft drinks, and some had lost weight after participating in KMT.</p> <p>Endorsement of women joining netball teams was widespread. Families and communities actively supported women's engagement in the netball program by coming along to watch them play, catering for games, and providing childcare and transport to games.</p>



Author/s (year)	Aim	Study design	Main findings
			<p>At the individual level, many women appreciated the social benefits of being a team member, and described how KMT had improved their motivation, confidence and leadership skills.</p> <p>Many highlighted how KMT had helped to strengthen their communities, because it brought together groups of women for a common purpose who previously did not have a specific reason for coming together.</p>
<p>Swinburn et al. (2011) (45)</p> <p>Fotu et al. (2011) (50)</p> <p>Swinburn et al. (2007) (46)</p> <p>Schultz et al. (2007) (47)</p>	<p>To determine the effectiveness of a whole-of-community intervention program (i.e. MYP) for obesity prevention in youth using quasi-experimental study design with intervention and comparison groups.</p>	<p>Quasi-experimental study design with intervention and comparison groups. School students from three districts in Tongatapu comprised the intervention group (n=1083), and all students of the same age from the island of Vava'u comprised the comparison group (n=1396). Data were collected pre and post intervention, with a mean duration between pre and post data collection points of 2.5 years.</p> <p>The primary outcome measures were changes in anthropometry and body composition, and the secondary outcome measures were changes in behaviours, knowledge, quality of life, body size perceptions and community capacity.</p> <p>Process evaluation data covered resource utilisation and analysed dose, frequency and reach for specific strategies.</p>	<p>The MYP action plan consisted of ten points that guided program development: capacity building; social marketing; evaluation; promoting healthy breakfast, school lunches, fruits and vegetables, and water consumption; increased organised sport and informal physical activities; and using role models as champions for the program.</p> <p>Both intervention and comparison groups showed similar increases in overweight and obesity prevalence (10.1% points and 12.6% points respectively).</p> <p>The overweight and obesity prevalence among male adolescents in both the intervention and comparison groups increased by +3.2 and +7.7 percentage points respectively, compared to female adolescents (+19.9 and +13.1 percentage points respectively), indicating that males benefited more from the intervention than females.</p> <p>There were no overall improvements in eating patterns or levels of physical activity when the intervention and comparison groups were compared.</p>
Fotu et al. (2011) (49)	<p>Reflection on process evaluation for MYP, against best practice principles for obesity prevention.</p>	<p>Process evaluation data covered resource utilisation and analysed dose, frequency and reach for specific strategies.</p>	<p>The interventions included a wide mix of activities targeted at the action plans. However, the intervention reach, frequency and dose varied widely across all activities, and showed no consistent pattern.</p>

<b>Author/s (year)</b>	<b>Aim</b>	<b>Study design</b>	<b>Main findings</b>
Uauy et al. (2011) (51) Schultz et al. (2011) (52)	These papers reflect on the lessons learned (of which there are too many to list) from MYP and discuss directions for future research	N/A	
Simmons et al. (2009) (48)	Reports on the process of developing community participatory action plans for obesity prevention projects in children and adolescents for the MYP project.	Stakeholder engagement processes were combined using the ANGELO Framework (scans for environmental barriers, targeted behaviours, gaps in skills and knowledge) and workshops with key stakeholders to create action plans from 2002 to 2005.	The ANGELO Framework is a flexible and efficient way of achieving an agreed action plan for obesity prevention with diverse communities.

### 3.6 Obesity-related policy

Six published articles examining obesity-related policy making processes and/or options for policy interventions in Tonga were identified. Thow et al. (2010) (60) presents a case study detailing the proposed restriction of mutton flap imports. The 'Fatty meat import quota Act', given ministerial in-principle support in 2004, recommended application of an import quota to all products that had >40% energy from fat and that contributed significantly to the fat and saturated fat consumption of Tongans. Only mutton flaps met these criteria, and the import quota was selected as an option because availability of imported foods appeared to be a more significant predictor of consumption than price (at the time, mutton flaps were similarly priced to local *mahi mahi* fish). However, the Act never reached Cabinet because of concerns that introducing a quota might be judged as trade distortion and therefore jeopardise Tonga's negotiations for accession to the World Trade Organization.

Three other articles reported on the implementation of obesity-related policy-making processes in relation to the Pacific Obesity Prevention in Communities (OPIC) project, but the authors did not recommend specific interventions. Snowden et al. (2010) (61) described the 'health impact assessment' process that can be used to assess the health impacts of non-health policies. Mavoa et al. (2012) (62) outlined the 'knowledge brokering' approach to building an organizational culture of evidence-informed policy development. Thow et al. (2011) (63) reported on the implementation of a 'multi-sectoral policy approach' that incorporated modified 'problem trees' and 'solution trees', whereby the authors worked with policy makers and other stakeholders to identify obesity-related problem areas, and then shortlist policy options to address them.

Snowden et al. (2010, 2011) (64, 65) described policy options that were systematically identified by stakeholders using the multi-sectoral policy approach articulated by Thow et al. (2011) (63). The authors also modeled the likely cost-effectiveness of the different options. Table 6 lists the 28 shortlisted policy options that were identified as likely to promote a healthy food environment in Tonga (64). The policy options targeted five problem areas: 1) increasing availability and access to local foods, 2) modifying the costs of healthier and less healthy foods and drinks, 3) healthier settings, 4) enhancing the promotion of healthier foods and controlling the marketing of less healthy foods, and 5) other. Cost-effectiveness modelling was applied to these policy options (65), and the results ranked (Table 7). Two policy options were ranked in the top five for both 'most effective' and 'lowest cost per death averted' – these were: 1) removing the price control for unhealthy oils (including dripping), and 2) increasing the import duty on sugar to 15%. A ban on the sale of fatty processed meats was assessed as the most effective policy option, yet it was also identified as one of the highest cost options per death averted, at least according to the expected costs incurred in the first year of implementation.

**Table 6: Twenty-eight shortlisted policy options identified as likely to promote a healthy food environment in Tonga**

Area of problem	Shortlisted policy option
Increasing availability and access to local foods	Establishment and support for farmers' and fishermen's co-operatives
	Licensing enforcement and price control for fruit, vegetable and fish middlemen <sup>a</sup>
	Removing license requirement for roadside vending of local produce
Modifying the costs of healthier and less healthy foods and drinks	Reduction of import duty on all fruits and vegetables (except those grown locally) to 0% <sup>a</sup>
	Implementation of price control on imported fruits and vegetables <sup>a</sup>
	Removal of import duty, and introduction of price control on imported tinned fish and seafood <sup>a</sup>
	Increase of import duty on butter to 15% <sup>a</sup>
	Reduce import duty of margarine to 0% <sup>a</sup>
	Remove less healthy cooking oils and dripping from the price control list <sup>a</sup>
	Introduce 15% excise duty on dripping and other animal fats <sup>a</sup>
	Increase import duty on mutton flaps, turkey tails and corned meats to 15% <sup>a</sup>
	Introduce 15% excise duty on mutton flaps and 50% excise duty on turkey tails <sup>a</sup>
	Remove less healthy meats from price control <sup>a</sup>
	Introduce 15% excise duty on soft drinks <sup>a</sup>
	Introduce price control for bottled water – increase import duty on sugar to 15% <sup>a</sup>
	Introduce 30% excise duty on confectionery <sup>a</sup>
	Introduce 15% excise duty on fried packet snack foods <sup>a</sup>
	Remove cheese from price control
	Reduce import duty on all beans and lentils to 0% <sup>a</sup>
	Reduce import duty on breakfast cereals to 0 % <sup>a</sup>
Healthier settings	All schools to implement school food & nutrition policy
	Food policy for government-run/funded workshops and meetings
Enhancing the promotion of healthier foods and controlling the marketing of less healthy foods	Low-cost advertising for health promotion
	Broadcasting censorship system and enforceable guidelines with regard to advertising accuracy and content
	Control over the use of children in unhealthy (specified by nutrient profiling system) food and drink advertising
	Comprehensive food safety legislation, including requirement for nutrition labelling
Other	Enforcement of licensing for roadside vendors (selling non-local foods) <sup>a</sup>

Source: Snowden et al 2010 (64) a. Indicates a modification to an existing policy.

**Table 7: Ranking of obesity-related policy options after cost-effectiveness modelling**

<b>Most effective policy options</b>	<b>Lowest costs (first year costs) per death averted</b>	<b>Higher costs (first year costs) per death averted</b>
1. Ban on sale of all fatty meats (including processed)	1. Removal licensing requirement for roadside vendors selling local produce	1. Price control for imported fruit
2. Ban on sale of fatty unprocessed meats	2. Import duty on sugar increased to 15%	2. Ban on sale of fatty processed meats
3. Price control for healthier meats	3. Fuel subsidy provided for fishermen	3. Price control for imported vegetables
4. Price control removed for unhealthy oils	4. Price control removed from dripping	4. Price control for imported seafood
5. Import duty on sugar increased to 15%	5. Import duty on all animal fats increased to 15%	5. Price control for bottled water

Source: Snowden et al. (2011)(65)

## 4. Discussion

This section of the report summarises, based on the literature review, what is currently known about obesity in Tonga, the public health implications of what is known, and the evidence gaps that remain.

### 4.1 What is known?

- The prevalence of overweight and obesity among people in Tonga is among the highest in the world, and there has been a clear, consistent and concerning increasing trend in prevalence.
- Obesity is more common in women than men.
- Obesity prevalence is relatively high among youth, and increases substantially with age.
- The validity of the international BMI cut-points for overweight and obesity among people in Tonga are contested and warrant further investigation.
- Food procurement, preparation and consumption are very much collective activities in Tonga, and are imbued with a range of important meanings related to social relationships and social status.
- For people in Tonga, the role of food as a source of fuel for the body and a contributor to good health is relatively less important than the social and cultural purposes it serves. Food is central to ceremonial and communal occasions; it is used to strengthen relationships with others and to communicate love and respect. The provision of an abundance of food confers status on both the providers and the recipients.
- A larger body size indicates that the person is well cared for by his/her family and well connected within the community – both highly valued attributes in a collectivist society.
- Tongan youth, even those who are classified as overweight or obese, have relatively high levels of body satisfaction compared with youth from a number of other countries.

- Tongan youth believe that the ideal male body is big with a well-muscled and strong upper body. The ideal female body is also large, but soft and round.
- Eating patterns in Tonga have changed substantially over the recent decades with a move away from consumption of more nutritious traditional foods towards energy-dense, nutrient poor, imported foods that are cheaper and more readily available (on the main island particularly), but not necessarily preferred by people in Tonga.
- The diet of many young people in Tonga is of poor quality and includes regular consumption of processed packaged snacks, confectionary and soft drinks. Many of their day-time meals are purchased outside of the home from school canteens and nearby shops that stock primarily unhealthy food choices.
- Participation in regular physical activity in Tonga appears to be sub-optimal for most people, although literature reporting on this variable is limited, the measures used are not uniform making comparisons over time difficult, and the levels reported seem to vary substantially.
- Tongan men are much more likely to participate in physical activity, including sport, than Tongan women. Tongan women are deterred from participation in physical activity by socio-cultural attitudes that prescribe how women should be using their time and how they should behave. A lack of structured opportunities and facilities are additional barriers to women's participation in physical activity.
- Despite encouraging improvements in the proportion of people in Tonga eating the recommended daily allowance of fruit and vegetables, and the proportion participating in high levels of physical activity between 2004 and 2012, uptake of these health promoting behaviours remains sub-optimal overall, and the prevalence of overweight and obesity have not decreased (10, 22).
- It is possible to design and implement successful large scale interventions for obesity prevention in Tonga such as the Kau Mai Tonga program, but maintaining the momentum generated by such initiatives may be a challenge that needs to be addressed.

#### **4.2 What is not known?**

A good deal of the research into socio-cultural constructions of health, illness, eating, physical activity and body image in Tonga is now fairly dated, but understanding contemporary socio-cultural aspects of health behaviours is essential when tailoring health promotion messages and designing and implementing health promotion programs. It is possible that some of the socio-cultural factors identified in the literature are now much less important, having been displaced by different social constructions of these concepts as the nature of Tongan society evolves over time given increasing exposure to outside influences. More up-to-date information could be obtained by high quality market researchers. This would help to ensure that any new health promotion campaigns and programs are appropriate for the current context of Tonga, and therefore ultimately more effective at achieving the goals of the National Strategy to Prevent and Control Communicable Disease.

Additionally, there are some obvious gaps in knowledge and understanding. Given the traditional, Christian culture that exists in Tonga, it is also notable that little is known about the role of the church as an important custodian of cultural practices that influence eating and exercise, and therefore obesity; including differences in relevant attitudes and policies between different Church denominations.

More detailed information about food purchasing patterns (who buys food, where from, and how are purchasing decisions made?) and food consumption patterns (e.g. the ratio of consumption between traditional versus non-traditional foods) is needed. Given the findings of Evans et al. (35, 41, 42) that the primary influence on food choice is availability (as opposed to preference), more needs to be known about the specific influences on food availability e.g. the impact of fresh fish exportation, the degree to which Tongans are continuing to grow their own food, and the proliferation of small retailers selling only packaged food. This information is critical to enable advocacy for effective policy and legislative change and for driving community action.

The questions asked in the STEPs survey were limited to the numbers of fruits and vegetables consumed each day. Information regarding portion sizes and consumption of energy-dense, nutrient poor foods would provide a more complete picture of eating patterns.

Similarly, information regarding physical activity patterns, and barriers and facilitators of physical activity among men is limited. While women have a higher prevalence of obesity and are less likely to engage in physical activity, these issues remain very important ones for the health of men as well. More information regarding non-recreational physical activity related to work and transport is needed for both men and women. Additionally, there is very little information available regarding the impact of changes in the natural and built environments on people's willingness and ability to engage in physical activity. Addressing broader structural impediments and facilitators of health behaviours has the potential to create impact beyond those who at the individual level are already willing to change their behaviours.

It is also clear that there is a lack of detailed, up to date epidemiological data. Whilst the STEPS survey makes a significant contribution, it only covers part of the population (25-64 year olds), and typically faces a considerable lead-time between enumeration and publication. Tonga may benefit from a strengthened health information system that is able to collect and collate consistent and reliable clinical data to report obesity related trends and patterns in a timely manner to support effective policy decision-making.

Finally, further research is required to understand the influences of trade policies on the availability of healthy food choices and the relationship between price and food choices. For example, more needs to be known about the impact of fish as a high value export on price and availability fresh fish in the domestic market.

### 4.3 Public health implications based on the review findings

Currently there is no formal mechanism for regular surveillance of non-communicable diseases prevalence and risk factors in Tonga. Given the public health significance of the problem, there is a need for scheduled surveillance surveys that systematically collect detailed information about patterns of eating, physical activity and body size in different localities, rural and urban populations, across both sexes, and across age-groups. Additionally, these data should be disaggregated by disability, including mental health, to ensure important questions about health equity can be answered. **Regular, planned, representative national health surveys (even if only every five years) that capture data related to obesity prevalence, risk factors, eating patterns and physical activity would provide valuable information regarding the effectiveness (or not) of policies and programs.** The design of such a survey, including the objectives, sampling strategy, and types of questions to be asked requires careful thought (and piloting). The findings of such a survey could serve as a point of triangulation against data available through a strengthened health information system.

**The socio-cultural meanings of food, eating and body size in the everyday lives of Tongans have to be taken into account when designing and implementing health promotion programs that aim to reduce obesity, if they are to be successful.** Campaigns that emphasise weight loss as their primary goal should be embarked upon with caution. Even in countries where being overweight/obese is highly stigmatised, opportunities for exercise are commonplace, and healthy foods are widely available, weight loss programs are not particularly successful, as evidenced by the increasing prevalence of obesity in these countries. Currently, young people in Tonga are relatively comfortable with their bodies, even when classified as overweight or obese. Campaigns that focus specifically on weight loss may achieve modest reductions in the prevalence of obesity (at best) at the risk of increasing the prevalence of body dissatisfaction and eating disorders among young people. A better approach may be to promote healthy eating and physical activity as important for maintaining health and preventing illness rather than as a means of achieving weight loss. There is a growing body of literature describing how it is possible to be ‘fit and fat’ – although this is true mainly for those who are overweight rather than obese (66,67). It may also be appropriate to position staying healthy as part of caring for your family and community.

**The development and implementation of policies and social marketing campaigns designed to reduce dependence on and consumption of unhealthy imported foods, and increase the sustainable production of locally grown traditional foods, including seafood, are indicated.** The findings of this literature review supports the importance of campaigns using a range of integrated actions to bring about sustained change at the community, organisational and individual level. Such actions need to include both mass media and settings based outreach to influence community action and advocacy for policy and



legislative change. It is important that the priorities and actions of integrated social marketing campaigns are driven by both epidemiological and market research evidence. A new campaigns could reposition what it means to be a loving caring family by providing an abundance of health traditional foods for children rather than imported less health foods i.e. slightly re-engineering the types of foods associated with being a caring, loving family. However these are suggestions and careful market research is required to inform such decisions. **Policies and programs that engage and mobilise the community through a settings based approach, especially settings such as churches and schools, are likely to achieve better outcomes than programs aiming to change behaviours at the individual level.**

**The fact that Tongan communities are characterised by strong social networks is another asset that can be mobilised to increase participation in physical activity. Given the collaborative nature of Tongan society, the promotion of group-based physical activities, such as team sports, group fitness, and walking groups, may be more successful than solo activities.** The success of the Kau Mai Tonga netball campaign is a good example of what can be achieved, but strategies for maintaining the initial positive impact of such initiatives and ensuring their sustainability are required. Heat and rain have been identified as barriers to sport based physical activity (2), and investment in covered playing spaces should be considered.

**Targeted promotion of physical activity for women is particularly important given the current barriers to participation and the fact that women are more likely to be overweight or obese.** Creating safe opportunities and spaces for women to partake in physical activity is important, and such an approach is more likely to be successful if it simultaneously serves a social purpose e.g. the formation of young mothers groups that can foster both physical activity and social exchange. Endorsement of women's participation in physical activity by community and church leaders would be another likely facilitator. Further research is required to understand the barriers and enablers of active transport (walking and cycling) as a strategy for increasing physical activity in Tonga.

It does seem that the people of Tonga generally have good knowledge of risk factors for non-communicable diseases; they are able to identify healthier foods and know that they should be engaging in physical activity, so clearly knowledge alone is not sufficient to achieve behavior change. Ongoing investigation into the barriers to healthy eating and physical activity is important if targeted interventions are to be successful. Related to this is the importance of well-planned monitoring and evaluation activities alongside all interventions, including careful collection of meaningful baseline data so that meaningful comparisons can be made at later stages of the intervention. Retrospective evaluations, in the absence of sound baseline measures, are never optimal.

While the work of Evans and colleagues regarding the impact of economic and trade agreements on health (35, 41, 42) has obvious implications for policies that aim to address

the increase in chronic diseases, it is important to note that the data are 15 years old, and the situation in 2015 may differ in some respects. Nevertheless, public health policy cannot be developed in isolation from trade policy. Ideally, trade policies need to be health sensitive i.e. take account of health impacts as well as the economic consequences of both current and emerging policies. The relationships between Tonga's trade agreements, the large-scale importation of processed foods, the changes in eating patterns, the increase in obesity, and the growing burden of chronic disease are complex, and beyond the scope of this review. However, it is very clear that the health problems associated with obesity in Tonga cannot be addressed in the absence of close scrutiny of these relationships, and subsequent development and implementation of corrective policies. Trade arrangements over the recent decades have arguably contributed in important ways to the increase in obesity and chronic disease. Accordingly, new policies may be necessary to undo the damage that has been caused by current trade agreements, while at the same time recognising and preserving any benefits that globalisation delivers to the people of Tonga.

As is already well-recognised, the high and increasing prevalence of obesity in Tonga is very likely to be a major contributor to the high prevalence of non-communicable diseases, which have significant implications for the social and economic well-being of individuals, families, communities and the country. A collaborative, multi-pronged approach that involves government ministries responsible for health, trade, education and infrastructure, along with the Church, is required if the current increasing trend in obesity prevalence is to be reversed.

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