



Food consumption pattern in Tonga based on 2015/2016 Household Income Expenditure Survey

FAOSAP in collaboration with Tonga Department of Statistics¹

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Executive summary

Based on the analysis of the food data collected in the 2015/16 Household Income and Expenditure Survey (HIES), undernourishment is not a major issue in Tonga. Statistics show that less than one person out of twenty has access to an amount of calories lower than that needed to meet daily requirements to have an healthy life and maintain a certain level of physical activity socially acceptable (as measure by the prevalence of undernourishment or Sustainable Development Indicator 2.1.1). This result is not surprising in a country ranked as one of the most obese countries in the world where 90% of adults older than 15 years are overweight and up to 40 percent of the population are said to have a weight-related coronary disease, diabetes, strokes and even a drop in life expectancy.

The relatively high level of average dietary energy consumption of 2900 kcal/person/day needs to be put in perspective with the level of average calorie requirements of 2370 kcal/person/day. The average calorie requirement for Tonga is also among the highest levels in the world due to the higher height of Tongan populations and their larger bones and muscle mass observed in comparison to that observed in Caucasian bodies.

Further analysis of the food data collected in the 2015/16 HIES reveals a diet rich in fats and poor in carbohydrates with relative contribution to the total energy consumed of 28% and 59% is at the limit of higher or lower FAO/WHO/UNU recommended norms for a balanced diet.

Meat, sugar and prepared food contribute alone to 30% of the total diet. Less than 20 food products contribute to more than 80% of the total calories consumed with cassava, chicken quarters, wheat flour, noodles, sugar and prepared food consumed away from home contribute alone to 50% of the diet.

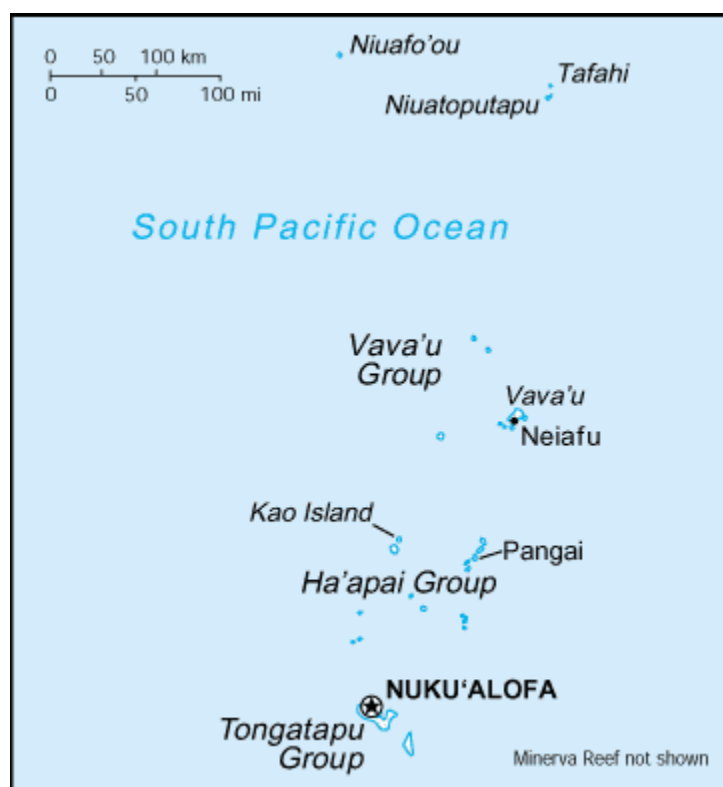
Access to food does not seem to be a major constraint in Tonga, however, not all households are confronted to the same access to food. Higher consumption is observed in rural areas compared to the capital city where food is a bit more expensive and more than 80% of the calories consumed are purchased.

On average at the national level, food expenditures contribute to about 45% of the total consumption expenditures, which means that the cost of food is not weighing too much on the overall household budget and this share seems to be constant no matter the level of total consumption expenditures.

All these results, however interesting and consistent with the overall food security status of the country, they still need to be treated and interpreted with caution. The survey was not preliminary designed to conduct such an analysis and food data collected present some limitations so that levels or indicators discussed in this report need to be interpreted as reflecting a trend rather than actual facts.

1. Introduction

Tonga officially named, the Kingdom of Tonga, belongs to the group of Islands of Polynesia. It is composed of 173 islands with a total area of 748 km² and a population of 103,000 people inhabiting only 53 of the islands. The capital city of Nuku'alofa is located in the main island of Tongatapu.



With a Human Development Index greater than 0.7² Tonga ranks fifth among Oceanian countries but still one person out of five was living under the national poverty line in 2015³. Tonga is known

². Source: Human Development Report. UNDP. 2016.

³. Source: Key indicators for Asia and the Pacific. Asian Development Bank. September 2018.

<https://www.adb.org/publications/key-indicators-asia-and-pacific-2018>

as the Friendly Islands, but unfortunately one with the highest obese population. More than 90% of adult older than 15 years are overweight. These trends are in line with the very low rate of undernourishment as less than 5% of the population is consuming an amount of calories lower than the minimum needed to maintain a healthy life and a certain level of physical activity socially acceptable.

Consumption of highly processed foods, relatively sedentary lifestyle, poor public education on diet, cultural factors such as feasting and festivals, preference given to imported food that have higher social status than local and healthy foods and large body sizes synonymous of wealth, power and beauty are among the main reasons that can explain obesity in the Pacific islands⁴.

If reaching the very ambitious goal of ending hunger by 2030 may be straightforward for Tonga, ensuring good health and well-being for all may be more challenging. If trends continue, SDG Target 3.4 to reduce by one third by 2030, premature mortality from non-communicable diseases through the prevention and treatment, as well as promote mental health and well-being will be difficult to reach. This given the mortality rate attributed to cardiovascular diseases, cancer, diabetes, or chronic respiratory disease (SDG indicator 3.4.1) was established at 23% in 2016⁵. Obesity is one of the major risks of developing non-communicable diseases. Achieving target 3.4 means developing nutrition policies to fight against obesity and address other health issues.

To inform nutrition policies however, data is essential. Not only anthropometric data on the height and weight of individuals but also data informing on diets of people. To date, no individual intake survey representative of the entire population is available for Tonga, the only source of information available are food data collected in Household Income Expenditure Surveys (HIES) conducted every five to ten years based on funding available. The last HIES was conducted from October 2015 to October 2016 (2015/16 HIES) by the Statistics Department of Tonga with the support from the Pacific Community (SPC). This report presents the major trends in food security and nutrition revealed by the analysis of the food data collected in the 2015/16 HIES. Indicators were estimated using the software ADePT-FSM developed jointly by FAO and World Bank⁶.

Based on the 2015/16 HIES it was estimated that less than five percent of the population in Tonga is undernourished. Prevalence rates of undernourishment are very similar to national rates for Tongatapu and other Islands averaging 5% of undernourishment. However the capital city tends to exhibit higher undernourishment mainly due to lower average dietary energy consumption that can be attributed to the fact that food away from home that is quite a significant behavior difference in Nuku'alofa, might not have been fully captured in the survey.

⁴. Source: Wikipedia : https://en.wikipedia.org/wiki/Obesity_in_the_Pacific

⁵. See foot note 3.

⁶. For more detail about ADePT-FSM refer to <http://www.fao.org/economic/ess/ess-fs/fs-methods/adept-fsn/en/>

The daily dietary energy consumption (DEC) per person per day is averaging 2900kcal/capita/day. Based on anthropometric information on height collected in the survey and the age sex structure of the population the average minimum energy required to be in good health and perform a light physical activity socially acceptable, is among the highest requirements estimated in the world, which averages about 1870 kcal/person/day. Such high requirements are attributed to the higher heights observed in Tonga compared to the region but also the larger bone and muscle mass observed in Polynesian bodies compared to Caucasian bodies.

Some slight disparities can be observed in the cost of acquiring 1000 kcalories that is 6% higher in urban areas of Tonga than in other areas (2.28T\$⁷ versus 2.14 T\$). Urban households are more vulnerable/exposed to price shock as food expenditures contributes to more than 80% of the total consumption expenditure, while this share is closer to 60% in rural areas.

A deeper analysis of the share of the main macronutrients contributing to the average DEC, found that at the national level, the diet is not balanced and too rich in fats (27%) and low in carbohydrates (59%)⁸. The trend exacerbates with income increases with fat consumption above the recommended level for about 50% of rich households. However more than 50% of the proteins consumed originates from animals, which is reflected by the high contribution of chicken in the total calories acquired⁹.

The diet is not diversified as only 18 food items out of the almost 300 collected in the survey contributes to 80% of the total calories consumed. Tubers (29% mainly cassava), cereals (22% mainly in the form of wheat flour, noodles and bread) and meat (13% mainly chicken) contribute alone to two third of the calories consumed.

If the overall food consumption pattern is consistent and as the survey was not designed to perform an analysis on food security and nutrition, some decisions needed to be taken during the process that may affect the overall magnitude of the estimates. It is therefore important when considering these results, to remind that there is a margin of error around each indicator.

⁷. Tongan pa'anga as the official currency, which is denoted as TOP and symbolized as T\$

⁸. According to the WHO norms, in a balanced diet, the contribution of proteins to the total calories consumed should be between 10 to 15%, share of fats should be between 15% and 30% and share of carbohydrates between 55% and 75%.

⁹. About 10% of the calories consumed are coming from poultry meat.

2. The survey

The 2015/16 Household Income and Expenditure Survey was developed to obtain information on the income, consumption pattern, incidence of poverty and tendency towards saving for different groups of people in Tonga in order to guide policy makers in framing socio-economic developmental policies and initiating financial measures for improving economic conditions for the people. The results of the survey would serve to update the base period and weighting system for the Consumer Price Index (CPI) as well as provide valuable statistical information on the household sector for Tonga's National Accounts estimates.

The field collection spread over a 12 months period (October 2015 to October 2016 and divided to 16 Rounds) to cover seasonality of income and expenditure. This was the first time ever that a HIES was conducted in such a way in Tonga. Previous HIES was conducted over four rounds – once every quarter. Very detailed information on household income and expenditure was collected from about 1,800 households spread around the Kingdom.

The 2015/2016 HIES was designed to provide statistically significant results by each of the six geographical areas (strata) in Tonga: Tongatapu (urban), Tongatapu (rural), Vava'u, Ha'apai, 'Eua and Ongo Niua. The sample was constrained by budget and access to outer islands (logistics), especially in Ha'apai and Ongo Niua, and, as a result, optimum sample allocations were not achieved.

1,803 households provided a valid response (98.8 percent response rate from a total sample of 1,824 HHs), which amounts to 10 percent of all HHs in Tonga¹⁰.

This HIES also was the first of its kind in Tonga to include questions on deprivation or the Deprivation Section. It consisted in 4 modules to collect socio-demographic information, expenditure and income; and a two-week diary to collect daily expenditure, gifts received and home produced items.

The household diary collected information on the household's daily expenditure on goods and services; and the harvest, capture, collection or slaughter of primary produce (fruit, vegetables and animals) by intended purpose (home consumption, sale or to give away).

¹⁰. More details about the survey and sampling design can be found in "Tonga – Household Income and Expenditure Survey – Full report", drafted jointly by SPC and TDoS. October 2017.

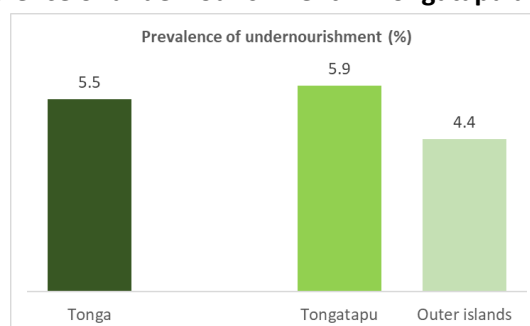
The survey collected quantities for about 300 food¹¹. Tobacco consumption was excluded from the food consumption analysis.

Quantities collected were converted from local unit of measurement (33 different units of measurement were identified) into metric weight using conversion factors when available and unit prices of one gram of product were used to convert all the remaining quantities¹². The nutrient values for 100 grams of edible quantities were allocated to each quantities converted in metric unit¹³. More details about the process can be found in Annex 11 of this document.

3. Results

Undernourishment is defined as the lack of access to enough calories to cover the minimum amount of calories needed to maintain a sedentary life style and be in good health. Based on food data collected in the 2015/16 HIES, about 5 people out of 100 is found to be undernourished in Tonga.

Graph 1. Prevalence of undernourishment in Tongatapu and Outer islands



There does not seem to be much difference between the main island of Tongatapu and the outer island, as in both areas undernourishment is close to the national rate of 5%¹⁴.

However with a level close to 12%, undernourishment seems to be much higher in the capital city of Nuku'alofa compared to rural areas due to higher requirements, slightly higher inequality

¹¹. Indeed, quantities were reported for more than 3000 food items which after proper coding collapsed to less than 300 food products. The questionnaires being in English, a second language for interviewers and respondents resulted in communication and interpretation variations of technical related questions in some cases and the same product was reported in many different ways in the diary.

¹². Conversion factors were provided partly from the quarterly report of the Domestic Market survey conducted by the Ministry of Agriculture and partly by the Department of Statistics of Tonga.

¹³. Nutrient conversion factors are coming from the Pacific Nutrient Database developed in collaboration with University of Wollongong and PCS.

¹⁴. Note that at the time this report was drafted, the prevalence of undernourishment methodology was under revision and based on the new methodology the estimated prevalence of undernourishment for Tonga, Tongatapu and outer island is close to 2.5% due to lower estimate of inequality in requirements.

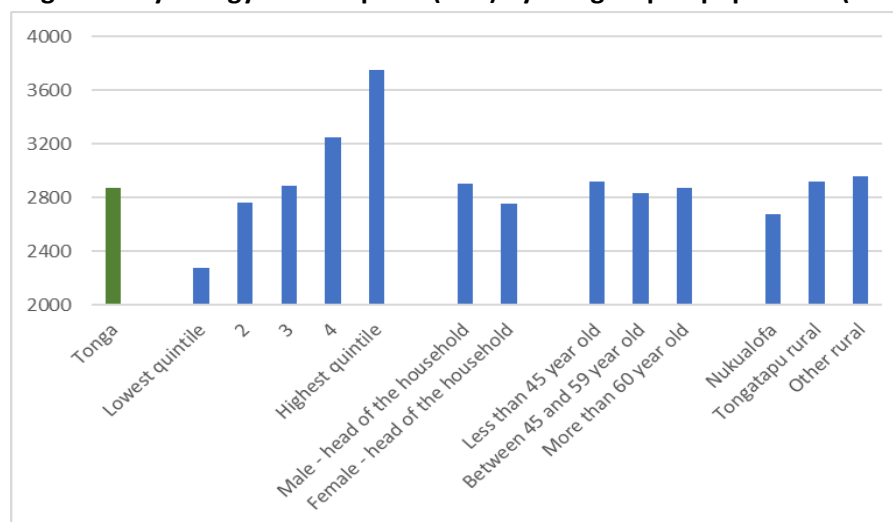
in accessing calories and lower level of average dietary energy consumption (DEC) as shown in table 1 that presents the prevalence of undernourishment and its main components^{15, 16}.

Table 1. Prevalence of undernourishment and its main components

	Number of sampled households	Population ('000s)	Average dietary energy consumption (kcal/capita/day)	Inequality in accessing calories as measured by the coefficient of variation of dietary energy consumption (%)	Minimum dietary energy requirement (kcal/capita/day)	Prevalence of undernourishment (%)
Total	1,803	101.8	2,873	25	1,875	5.5
Nukualofa	479	23.1	2,678	27	1,909	12.3
Tongatapu rural	479	52.5	2,916	24	1,867	3.9
Other rural	845	26.2	2,957	26	1,862	4.4
Tongatapu	958	75.6	2,844	25	1,880	5.9
Outer islands	845	26.2	2,957	26	1,862	4.4

The national average dietary energy consumption (DEC) is close to 2900 kcal/person/day which may be slightly under estimated due to the under reporting of the food consumed away from home¹⁷. This is further evidenced by the lower level of DEC in urban areas (2700 kcal/person/day) and the share of calories consumed away from home in urban areas (only 5% of the total calorie consumed while it is believed this share should be higher).

Graph 2. Average Dietary Energy Consumption (DEC) by sub group of population (kcal/person/day)



¹⁵. For a brief introduction to the methodology of the prevalence of undernourishment refer to the FAO SDG website: <http://www.fao.org/sustainable-development-goals/indicators/211/en/>.

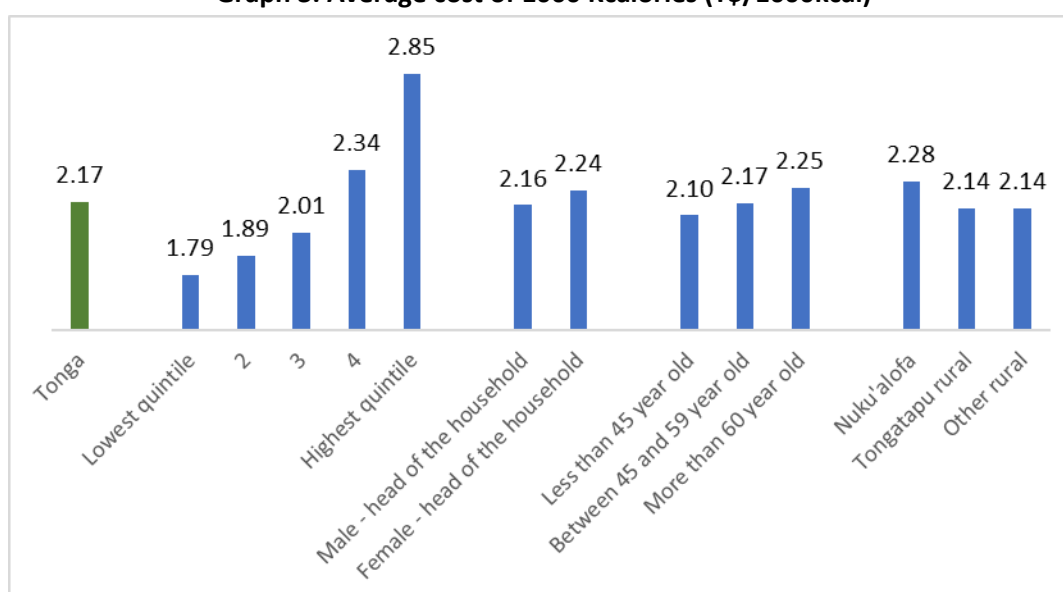
¹⁶. It is however believed that this level of undernourishment in Nuku'alofa is slightly biased upwards by the under reporting of the food consumed away from home in the capital city.

¹⁷. Important to distinguish between prepared food purchased to be consumed in the house by all the household members and that were relatively well reported in the diary and the food consumed away from home by each member of the household that is **more difficult** to report by the person who filled the diary and who may not be aware of this individual consumption.

Even if access to calories does not seem to be an issue, rich¹⁸ households still consume on average 65%¹⁹ more calories than poorer households and average DEC in the male headed households is higher than average DEC in households headed by females, and calories consumption is also higher in outer island compared to Tongatapu (Annex Table 2).

Food expenditures contribute to 45% of the total consumption expenditures (or 50% of total income) (annex tables 2 and 5) and it costs on average 2.17T\$ to acquire 1000 kcal in Tonga (annex table 2). In the Capital city the slightly higher inequality in accessing food is the result of slightly higher cost of the calorie as it costs on average 6% more to acquire 1000 calories in Nuku'alofa than in the other areas of Tonga.

Graph 3. Average cost of 1000 Kcalories (T\$/1000kcal)



Rich household also spend on average 60% more to acquire 1000 Kcal than more vulnerable households mainly due to the higher consumption of more expensive prepared food (Annex table 2). More than 11% of the calories consumed by rich households is coming from prepared foods compared to 7% in poor households. On average, rich households would spend 2.9T\$ to acquire 1000kcal of processed foods compared to 1.62T\$ spent by poor households to acquire the same amount of calories (Annex Table 3).

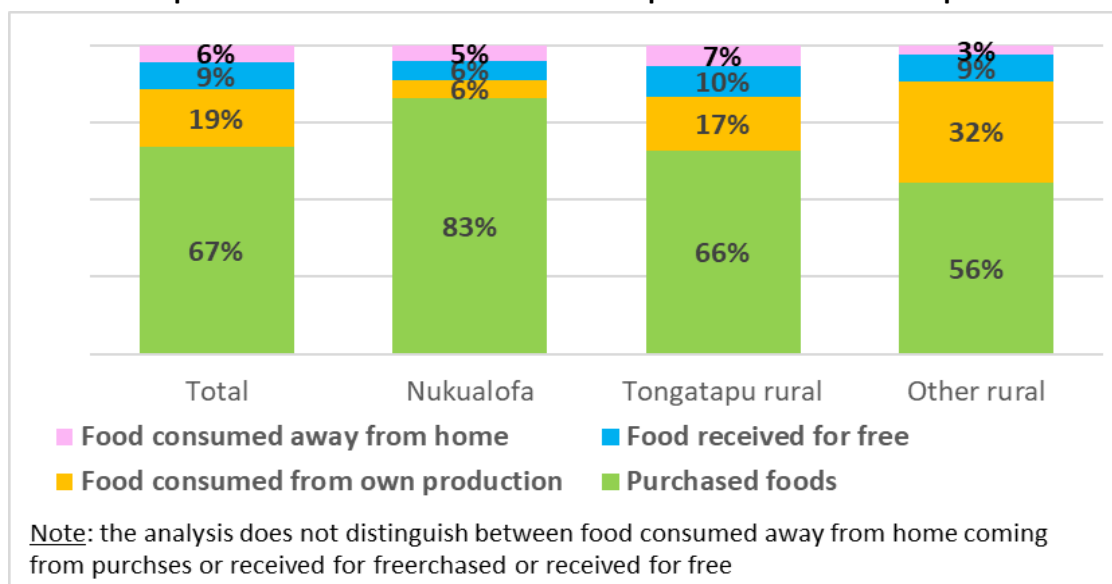
¹⁸ The classification of households is based on income distribution as estimated by SPC and not on total consumption expenditure as used by the World Bank to estimate poverty. For the first three deciles of income, average per capita total consumption expenditure was higher than the average per capita income. The inequality to access calories based on total consumption expenditures is much higher than that based on income.

¹⁹ Note that inequality in access to food decreases when levels of consumption are expressed in adult male equivalent to account for the composition of the household. Rich household consume only 50% more than poorer households compared to 60% when expressed on a per capita basis.

Households headed by a female or a person more than 60 years old would also spend slightly more to acquire 1000 kcal than households whose head is a male or is younger.

About two thirds of the calories consumed at national level are purchased while about one fifth are coming from own production. Wide disparities between Nuku'alofa, rural areas of Tongatapu and outer islands as more than 80% of the calories consumed in Nuku'alofa are purchased while 30% of calories consumed in outer islands are coming from their own production.

Graph 4. Contribution of the sources of acquisition to food consumption



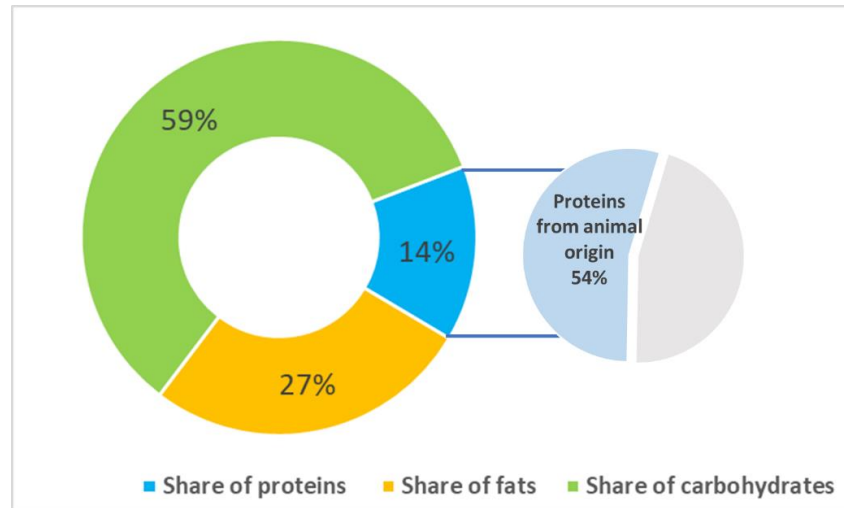
Food received for free is quite important as it contributes to 9% of the total calories consumed and seems to be slightly more important in rural areas than in urban areas and no matter the income level, about 9% of the calories consumed by rich or poor households are received for free. Some differences can however be observed between female and male headed households as 14% of calories consumed in female headed households are received for free while this share falls to 10% in male headed households who tend to rely more on own production than female headed households. Food consumed away from home contributes to about 6% of total calories consumed at national level. However, it is believed this share is higher in urban area where food consumed away from home might not have been fully reported (see Annex Tables 4 and 5).

With a contribution to the total dietary energy consumed of proteins, fats and carbohydrate respectively 14%, 27% and 59%, at the national level, the diet seems to be relatively unbalanced towards high consumption of fats and low consumption of carbohydrates compared to WHO/FAO/UNU recommendations for a balanced diet²⁰. The share of protein is within the range of recommended intakes and more than 50% of the proteins consumed are from animal origin

²⁰. According to WHO/FAO/UNU norms, respective share of proteins, fats and carbohydrates in total dietary energy consumption should be between 10 to 15%, 15 to 30% and 55 to 75%.

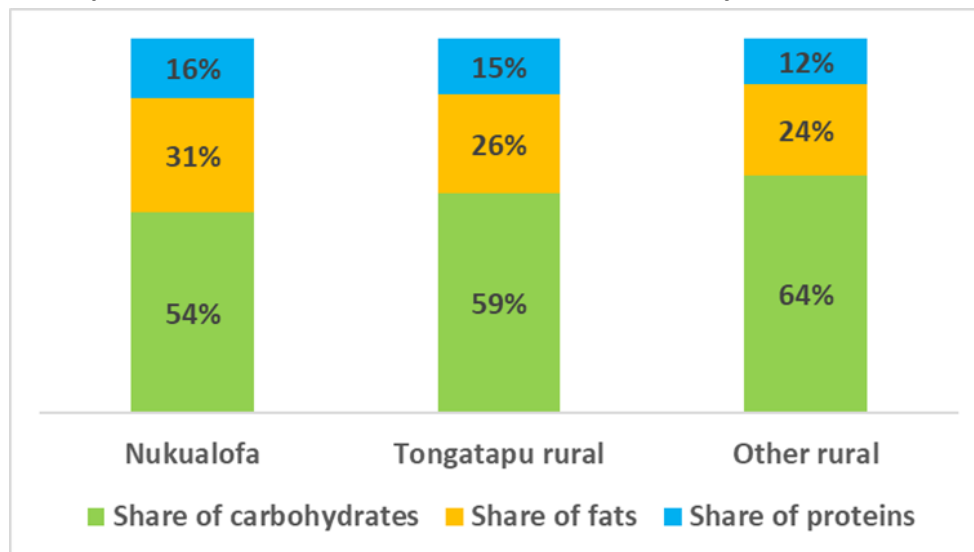
which are considered to be complete sources of protein because they contain all of the essential amino acids that our body needs to function effectively²¹.

Graph 5. Macro nutrient contribution to dietary energy consumption (%)



Disparities can be observed in contribution of macro nutrients to the total diet between Nuku'alofa urban area compared to rural areas. In Nukualofa, the diet is very low in carbohydrates (which is lower than the recommended level as less than 55% of calories are coming from carbohydrates), and very rich in fats compared to rural areas of outer islands which present a more balanced diet.

Graph 6. Macro nutrient contribution to total calories by area of residence



²¹. While animal proteins tend to contain a good balance of all the amino acids that we need, some plant proteins are low in certain amino acids. Animal protein sources, such as meat, fish, poultry, eggs and dairy, are similar to the protein found in our body. though too much red processed consumption may cause heart disease but one study also found that replacing 1 serving per day of red meat with 1 serving of poultry was associated with a 27% lower risk of stroke (7). <https://www.healthline.com/nutrition/animal-vs-plant-protein#section>.

A further analysis at the household level shows that for 45% of rich households, the contribution of fats to the total energy is higher than the upper range of recommended level of 30%. The contribution of carbohydrates to the total energy consumed by two third of rich households is lower than the lower bound of recommended level of 55%. If poor households tend to consume less calories than rich households they also tend to have a more balanced diet as 36% of poor households present a balanced diet compared to only 18% of rich households (table 2 and annex table 7).

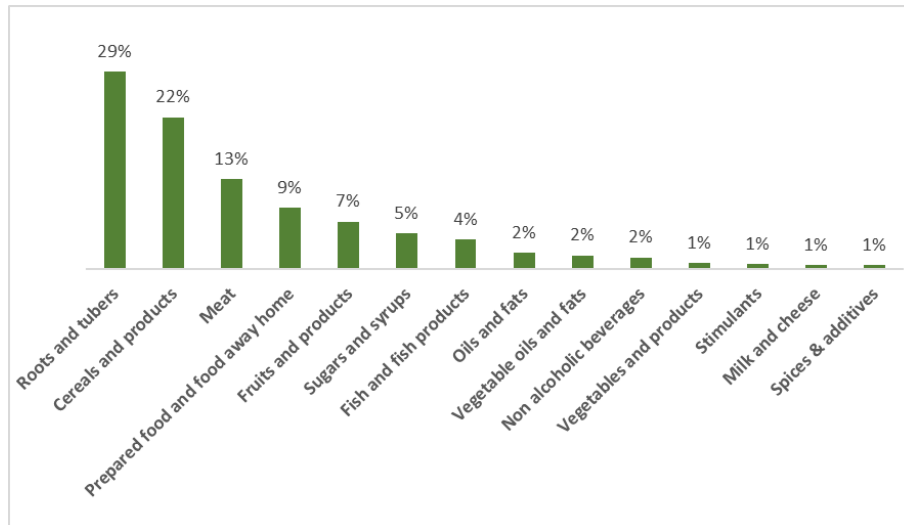
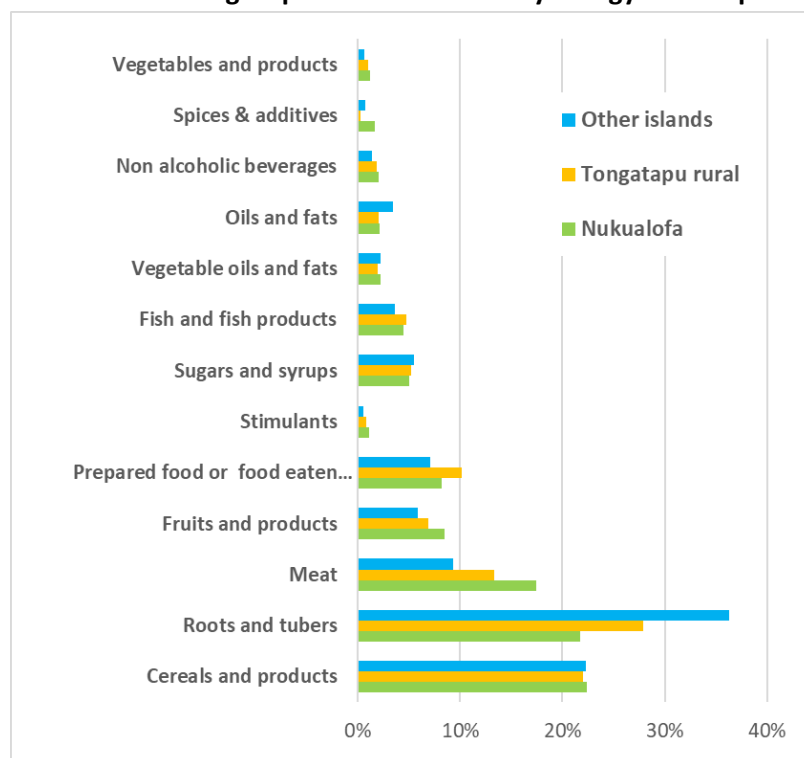
Table 2. Percentage of households having access to

	A balanced diet	Dietary energy provided by protein below the lower recommended threshold (10%)	Dietary energy provided by total fat above the upper recommended threshold (30%)	Dietary energy provided by total carbohydrates below the lower recommended threshold (55%)
Tonga				
Lowest quintile	36.1	24.2	30.0	29.3
Highest quintile	18.3	13.3	45.1	50.5
Nuku'alofa				
Lowest quintile	34.6	12.5	42.3	39.7
Highest quintile	19.4	4.2	58.2	65.7
Tongatapu rural				
Lowest quintile	38.9	18.2	32.2	33.8
Highest quintile	17.9	11.4	38.3	43.7
Other rural				
Lowest quintile	33.6	38.1	20.3	18.0
Highest quintile	17.4	29.8	41.9	44.5

In terms of diversity of the diet, five groups of food products contribute to 80% of the total dietary energy consumed, with roots and tubers as well as cereals contributing alone to 50% of the total dietary energy consumed (respectively 29% that is about 620 grams per capita per day and 22% of that is 180 grams of cereal per capita per day), followed by meat (13%, about 180 grams per capita per day of meat), prepared food (9%) and fruit and products (7%).

With an average consumption of about 270 grams per capita per day, fruits and vegetable consumption is well below recommended level of daily consumption of 400 grams per capita²².

²². Fruits and vegetables play an important role in a healthy diet. A diet rich in fruits and vegetables can help lower blood pressure, reduce risk of cardiovascular problems, and prevent some types of cancer (WHO, 2003). WHO and

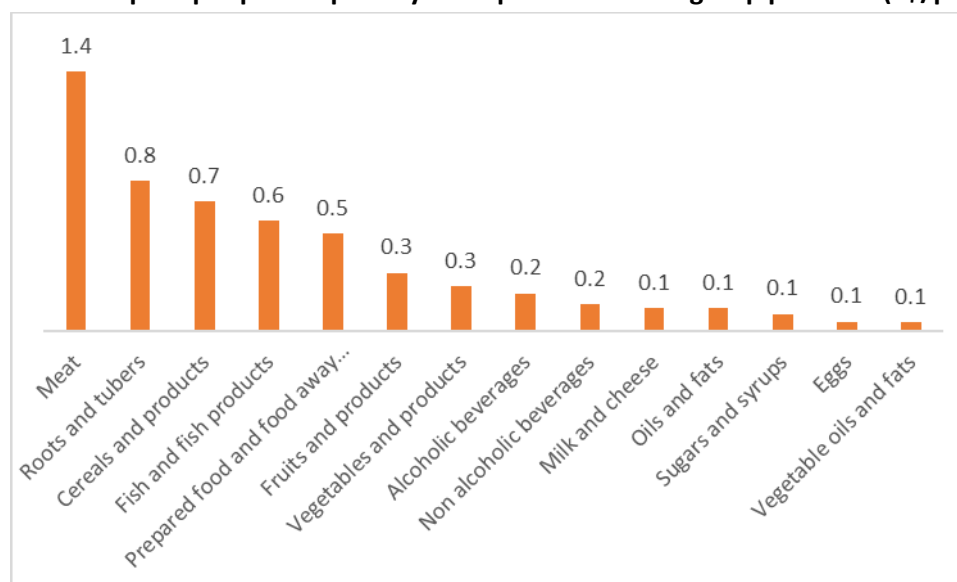
Graph 7. Contribution of main food groups to the total dietary energy consumption at national level**Graph 8. Contribution of main food groups to the total dietary energy consumption at national level**

This pattern does not reflect urban and rural disparities as roots and tubers contribute to more than one third of the total calories consumed in outer islands while in Nuku'alofa, cereal and tubers contribute to about the same amount but contribution of meat is quite substantial with 17% of calories consumed coming from meat products.

FAO recommend a daily consumption of at least 400 grams of fruits and vegetables (excluding potatoes and other starchy tubers) (WHO, 2003).

The average amount spent to acquire meat represents one fourth of total amount spent to acquire food with an average of 1.4T\$ spent per person per day to acquire meat. With 0.8T\$ per person per day, roots and tubers represent the second major food expenditures.

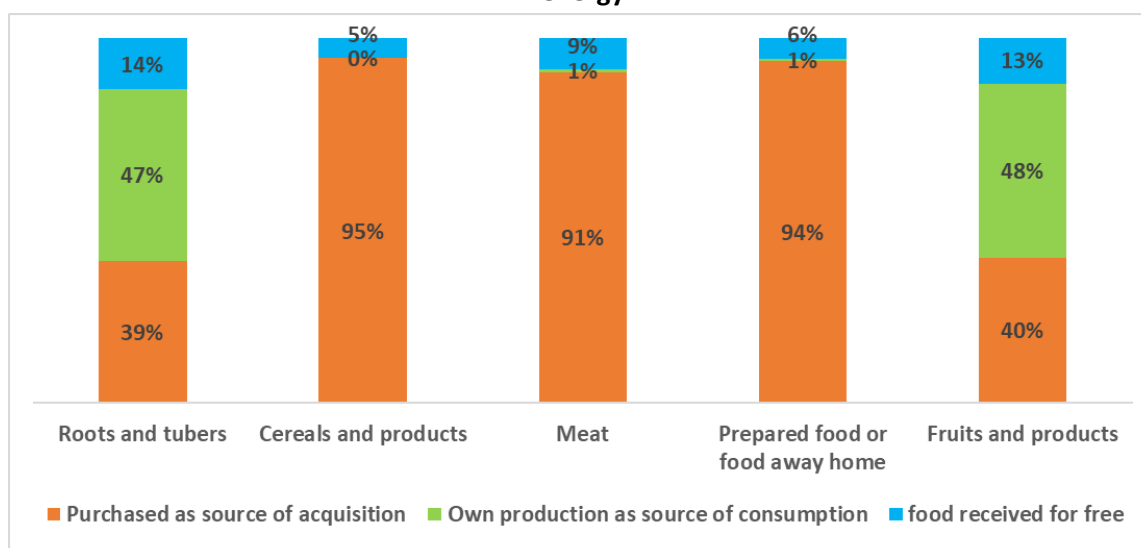
Graph 9. Amount spent per person per day to acquire main food group products (T\$/person/day)



Of the five food groups contributing to 80% of the calories consumed, roots and tubers as well as fruits and products are mainly coming from people's own production (respectively 47%, and 48% at national level and about 55% in rural areas) while more than 95% of the cereals and meats consumed are purchased. The is also importance of food received for free as 14% and 13% respectively of the energy consumed from roots and tubers and fruits are received for free (Annex tables 10 and 11 - number in red).

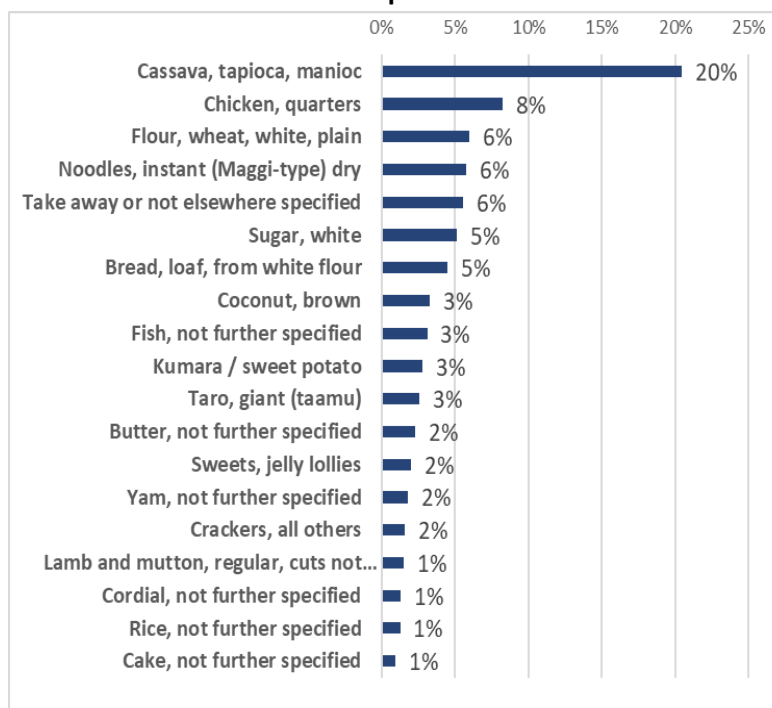
Not highlighted in the graph 10, but one fifth of the calories consumed from fish and fish products are received for free as gift from other households.

Graph 10. Contribution of purchases and own production as main source of acquisition of dietary energy



Of almost 300 food products reported in the survey, 18 alone contribute to 80% of the calories consumed at the national level. Cassava/tapioca/manioc are the main food products consumed in Tonga with a contribution of 20% to the total DEC, followed by chicken quarters (9%), flour wheat (6%), instant noodles (6%), sugar (5%) and loaf of bread (5%).

Graph 11. Contribution of main food product to the total calories consumed



Access to food imports is facilitated by the fact that the main port is located in Nuku'alofa and therefore better access to a higher variety of food products. Overall the diet is slightly more diversified in Nukualofa than in rural areas, with on average 13 products contributing to 70% of the total calories consumed compared to 12 in other rural areas of Tongatapu and 11 in outer islands.

Table 12. Main food products contributing to 70% of the total calories consumed by region

Nukualofa		Tongatapu rural		Other rural	
Cassava, tapioca, manioc	16%	Cassava, tapioca, manioc	19%	Cassava, tapioca, manioc	26%
Chicken, quarters	11%	Chicken, quarters	9%	Flour, wheat, white, plain	8%
Bread, loaf, from white flour	6%	Take away or not elsewhere specified	7%	Noodles, instant (Maggi-type) dry	6%
Take away or not elsewhere specified	6%	Noodles, instant (Maggi-type) dry	6%	Sugar, white	5%
Flour, wheat, white, plain	5%	Sugar, white	5%	Chicken, quarters	5%
Sugar, white	5%	Flour, wheat, white, plain	5%	Taro, giant (taamu)	4%
Coconut, brown	5%	Bread, loaf, from white flour	5%	Kumara / sweet potato	3%
Noodles, instant (Maggi-type) dry	5%	Fish, not further specified	3%	Butter, not further specified	3%
Fish, not further specified	3%	Taro, giant (taamu)	3%	Coconut, brown	3%
Kumara / sweet potato	3%	Coconut, brown	3%	Take away or not elsewhere specified	3%
Butter, not further specified	2%	Kumara / sweet potato	3%	Bread, loaf, from white flour	3%
Mutton flaps	2%	Sweets, jelly lollies	2%		
Rice, not further specified	2%				

Cassava/manioc/tapioca remains the major food consumed in all the three regions but the contribution of this food item to the total calories consumed is 10 percentage points higher in outer islands than in Nuku'alofa (26% versus 16%). A better knowledge of the main food products

that are consumed, where they are consumed and what are consumer preferences can be of real help when trying to address nutrition programs aiming at fighting obesity and overweight.

Conclusion

SDG Target 2.1 aims at “ending hunger and ensuring access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round by 2030”. Two indicators have been selected to monitor this target. The prevalence of undernourishment (SDG 2.1.1) and the prevalence of moderate or severe food insecurity based on the food insecurity experience scale (SDG 2.1.2). Using food data collected in the 2015/16 Household Income and Expenditures Survey of Tonga, it has been possible to derive the first SDG 2.1.1 indicator for a Small Pacific Island entirely based on the household survey²³. The analysis reveals that undernourishment is not an issue in Tonga. This finding is in line with other comparable statistics and research highlighting Tonga being home to one of the world's highest overweight and obese populations. Food insecurity can contribute to overweight and obesity and low rate of undernourishment can coexist with high rates of malnutrition. Indeed, all the indicators presented in this report tend to point towards access to sufficient food but whose quality and diversity are poor.

Average dietary energy consumed in Tonga stands at a relatively high level of 2900 kcal/capita/day with average requirements of 2370kcal/person/day mainly due to higher heights of Tongan people and also their larger bone and muscle mass compared to Caucasian people.

Tongan population would spend on average 2.17 \$T to acquire 1000 kcal and food expenditures contributes to 45% to total consumption expenditures which means that accessing food in Tonga is not a major issue. With more than 80% of the calories consumed coming from purchases, urban households are more vulnerable to food price fluctuations while sources of food acquisition in outer islands rural areas are more diversified with more than 30% of the food consumed coming from people’s own production and about 10% is received for free.

Diet is relatively high in fats and low in carbohydrates. Protein consumption is within the recommended norms for a balanced diet and fifty percent of the protein consumed are from origin animals. Five main food groups contribute to 80% of the total calories consumed with large contributions of roots and tubers in rural areas (about 30% of the total calories consumed) and cereals in Nukualofa (22% of total calories consumed).

²³. The seven SDG 2.1.1 indicators estimated for the region (Fiji, New Caledonia, Solomon Island, Vanuatu, Kiribati, Samoa and French Polynesia) in context of the global monitoring are based on macro data on dietary energy supply from the food balance sheets.

Finally, these results need to be considered with caution and trends or pattern should be reflected upon rather than values per se as the 2015/16 HIES was not initially designed to conduct a food security and nutrition analysis. Hence, even if the food data collected in the survey offers a very rich and precious source of information, it should be complemented with targeted individual intake and anthropometric surveys. Indeed information on weight and height of each household member was also collected in the 2015/16 but because of the gaps in the data this information could not be exploited and used to further inform on nutritional status of children and adults.

Annex 1. Prevalence of Undernourishment

	Number of sampled households	Number of represented households ('000s)	Population ('000s)	Average dietary energy consumption (kcal/capita/day)	Inequality in accessing calories as measured by the coefficient of variation of dietary energy consumption (%)	Skewness of dietary energy consumption	Minimum dietary energy requirement (kcal/capita/day)	Prevalence of undernourishment (%)	Average dietary energy requirement (kcal/capita/day)
Tonga	1,803	18.0	101.8	2,873	25	0.77	1,875	5.5	2,371.3
Nuku'alofa	479	4.1	23.1	2,678	27	0.82	1,909	12.3	2,428.2
Tongatapu rural	479	8.8	52.5	2,916	24	0.74	1,867	3.9	2,358.6
Other rural	845	5.1	26.2	2,957	26	0.78	1,862	4.4	2,346.7
Tongatapu	958	12.9	75.6	2,844	25	0.76	1,880	5.9	2,379.8
Outer islands	845	5.1	26.2	2,957	26	0.78	1,862	4.4	2,346.7

Annex 2. Selected food consumption statistics

	Number of sampled households	Average household size	Average dietary energy consumption (kcal/capita/day)	Average dietary energy consumption per adult equivalent	Minimum dietary energy requirement (kcal/capita/day)	Average food consumption in monetary value (T\$/capita/day)	Average dietary energy unit value (T\$/1000kcal)	Average total consumption in monetary value (T\$/capita/day)
Tonga	1,803	5.7	2873	3913	1875	5.60	2.17	12.53
Quintiles of income								
Lowest quintile	421	7.1	2276	3187	1850	3.68	1.79	7.45
2	362	6.5	2763	3862	1841	4.65	1.89	9.67
3	348	6.3	2884	3978	1870	5.40	2.01	11.60
4	356	4.8	3247	4292	1914	6.87	2.34	15.63
Highest quintile	316	3.5	3753	4844	1945	10.03	2.85	26.00
urban rural								
Urban	479	5.6	2678	3535	1909	5.57	2.28	13.92
Rural	1,324	5.7	2930	4024	1865	5.61	2.14	12.13
Category for the size of the household								
Between 1 and 3 household members	426	2.2	4555	5799	1954	11.00	2.63	24.93
Between 4 and 6 household members	743	5.0	3058	4182	1883	6.11	2.14	13.99
More than 7 household members	634	9.0	2447	3395	1855	4.29	1.87	9.33
Gender of the head of the household								
Male	1,442	5.8	2903	3940	1882	5.64	2.16	12.46
Female	361	5.2	2752	3806	1846	5.47	2.24	12.80
Categories for the age of the head of the household								
Less than 45	603	5.5	2920	4164	1828	5.51	2.10	11.93
Between 45 and 59	588	6.0	2831	3640	1952	5.56	2.17	13.20
More than 60	612	5.5	2868	3937	1844	5.74	2.25	12.46
Area Residence								
Nukualofa	479	5.6	2678	3535	1909	5.57	2.28	13.92
Tongatapu rural	479	6.0	2916	4017	1867	5.46	2.14	12.77
Other rural	845	5.2	2957	4038	1862	5.92	2.14	10.82

Annex 3. Contribution of main food groups to the diet of rich and poor households and associated unit caloric cost

	Lowest income quintile		Highest income quintile	
	Contribution to total calories (%)	Cost of 1000kcal (T\$/1000kcal)	Contribution to total calories (%)	Cost of 1000kcal (T\$/1000kcal)
Cereals and products	25.5%	1.00	18.8%	1.50
Roots and tubers	30.6%	0.87	27.0%	1.29
Sugars and syrups	5.7%	0.62	4.4%	0.82
Tree nuts	0.3%	1.32	0.4%	2.30
Vegetables and products	0.8%	8.78	1.2%	10.19
Fruits and products	6.2%	1.48	9.1%	2.12
Stimulants	0.5%	1.12	0.2%	5.69
Spices & additives	0.4%	1.23	1.1%	0.78
Alcoholic beverages	0.1%	16.97	0.8%	23.44
Meat	12.8%	3.48	13.0%	4.87
Eggs	0.2%	7.09	0.4%	7.40
Fish and fish products	3.7%	4.75	5.1%	4.84
Milk and cheese	0.5%	5.73	1.1%	7.67
Vegetable oils and fats	1.9%	0.76	2.1%	1.07
Oils and fats	2.2%	1.62	2.7%	2.43
Non alcoholic beverages	1.5%	2.30	1.9%	4.48
Processed food, food eaten away from home and miscellaneous	7.0%	1.62	10.8%	2.90

Annex 4. Shares of food consumption by food sources (in dietary energy)

	Number of sampled households	Number of represented households ('000s)	Proportion of purchased food as total food consumed (%)	Proportion of own produced food as total food consumed (%)	Proportion of food consumed away from home as total food (%)	Proportion of food consumed from other sources as total food (%)
Tonga	1,803	18.0	66.98	18.73	5.57	8.72
Quintiles of income						
Lowest quintile	421	3.6	65.27	21.22	4.66	8.85
2	362	3.6	65.81	20.82	5.35	8.02
3	348	3.6	68.54	17.09	5.41	8.97
4	356	3.6	68.16	16.29	5.96	9.59
Highest quintile	316	3.6	68.22	16.09	7.60	8.14
urban and rural areas						
Urban	479	4.1	82.63	6.02	5.01	6.34
Rural	1,324	13.9	62.39	22.46	5.74	9.42
Gender of the head of the household						
Male	1,442	14.1	66.01	20.40	5.50	8.10
Female	361	3.9	70.87	12.05	5.86	11.22
Categories for the age of the head of the household						
Less than 45	603	6.2	68.24	16.66	6.59	8.51
Between 45 and 59	588	5.7	67.57	18.64	5.45	8.35
More than 60	612	6.1	65.11	20.91	4.67	9.31
Area Residence						
Nukualofa	479	4.1	82.63	6.02	5.01	6.34
Tongatapu rural	479	8.8	65.78	17.46	6.96	9.81
Other rural	845	5.1	55.60	32.49	3.27	8.65

Annex 5. Shares of food consumption by food sources (in monetary value)

	Number of sampled households	Number of represented households ('000s)	Proportion of food consumption in total income (%)	Proportion of food consumption in total consumption expenditures (%)	Proportion of purchased food as total food consumed (%)	Proportion of own produced food as total food consumed (%)	Proportion of food consumed away from home as total food (%)	Proportion of food consumed from other sources as total food (%)
Total	1,803	18.0	50.08	45.82	70.70	13.57	5.16	10.57
Quintiles of income								
Lowest quintile	421	3.6	82.89	46.65	67.65	15.68	4.50	12.16
2	362	3.6	50.00	47.02	71.04	14.00	4.60	10.36
3	348	3.6	39.47	46.05	72.26	12.78	5.20	9.76
4	356	3.6	33.92	44.92	72.47	11.99	5.29	10.25
Highest quintile	316	3.6	24.10	42.00	71.04	12.01	7.35	9.60
Gender of the head of the household								
Male	1,442	14.1	50.98	46.25	70.40	14.72	5.09	9.79
Female	361	3.9	46.51	44.11	71.91	8.96	5.44	13.69
Categories for the age of the head of the household								
Less than 45	603	6.2	54.93	46.74	72.12	11.72	6.04	10.12
Between 45 and 59	588	5.7	46.62	44.18	70.87	14.00	5.21	9.91
More than 60	612	6.1	48.71	46.55	69.10	14.99	4.23	11.68
Area Residence								
Nukualofa	479	4.1	47.33	41.22	83.99	3.76	4.77	7.48
Tongatapu rural	479	8.8	45.68	43.40	70.60	11.62	6.36	11.42
Other rural	845	5.1	61.46	54.79	59.17	26.17	3.08	11.58

Annex 6. Nutrient contribution to dietary energy consumption

	Number of sampled households	Number of represented households ('000s)	Average dietary energy consumption (kcal/capita/day)	Proportion of energy consumed as protein (%)	Proportion of energy consumed as fats (%)	Proportion of energy consumed as carbohydrates (%)
Total	1,803	18.0	2873	14.35	26.81	58.83
Quintiles of income						
Lowest quintile	421	3.6	2276	13.53	25.43	61.05
2	362	3.6	2763	13.79	26.24	59.97
3	348	3.6	2884	14.64	27.36	57.99
4	356	3.6	3247	15.20	27.03	57.76
Highest quintile	316	3.6	3753	15.40	29.39	55.21
Category for the size of the household						
Between 1 and 3 household members	426	4.6	4555	14.63	27.25	58.13
Between 4 and 6 household members	743	7.3	3058	14.47	27.05	58.49
More than 7 household members	634	6.1	2447	14.23	26.58	59.19
Gender of the head of the household						
Male	1,442	14.1	2903	14.24	26.40	59.36
Female	361	3.9	2752	14.82	28.49	56.70
Categories for the age of the head of the household						
Less than 45	603	6.2	2920	14.01	27.36	58.63
Between 45 and 59	588	5.7	2831	14.84	27.17	57.99
More than 60	612	6.1	2868	14.21	25.90	59.89
Area Residence						
Nukualofa	479	4.1	2678	15.70	30.72	53.58
Tongatapu rural	479	8.8	2916	14.81	26.44	58.75
Other rural	845	5.1	2957	12.26	24.12	63.62

Annex 7. Nutrient contribution to dietary energy consumption at income quintile level

	Number of sampled households	Number of represented households ('000s)	A balanced diet	A diet which does not meet any of the three recommended goals for energy-supplying macronutrients	Dietary energy provided by protein below the lower recommended threshold (10%)	Dietary energy provided by protein above the upper recommended threshold (15%)	Dietary energy provided by total fat below the lower recommended threshold (15%)	Dietary energy provided by total fat above the upper recommended threshold (30%)	Dietary energy provided by total carbohydrates below the lower recommended threshold (55%)	Dietary energy provided by total carbohydrates above the upper recommended threshold (75%)
Tonga										
Lowest quintile	421	3.6	36.1	27.0	24.2	27.2	12.7	30.0	29.3	13.1
2	362	3.6	31.7	24.8	21.4	31.8	11.3	30.9	33.8	10.9
3	348	3.6	25.5	26.2	15.5	39.1	11.0	38.5	36.7	8.8
4	356	3.6	27.2	27.4	14.6	45.1	8.0	34.8	34.7	5.6
Highest quintile	316	3.6	18.3	28.8	13.3	45.4	7.5	45.1	50.5	7.9
urb_rur										
Urban										
Lowest quintile	78	0.7	34.6	33.9	12.5	38.5	7.4	42.3	39.7	7.4
2	82	0.7	27.7	40.2	17.2	44.1	6.6	47.6	44.0	5.3
3	91	0.8	16.9	37.4	10.0	53.2	4.0	55.4	52.3	2.8
4	114	0.9	21.8	37.8	9.0	57.3	2.8	49.3	54.4	2.1
Highest quintile	114	1.1	19.4	37.4	4.2	54.5	1.8	58.2	65.7	2.7
Rural										
Lowest quintile	343	2.9	36.5	25.3	27.1	24.3	14.0	26.9	26.7	14.5
2	280	2.9	32.6	21.4	22.4	29.1	12.3	27.2	31.5	12.2
3	257	2.8	28.0	23.1	17.0	35.1	12.9	33.7	32.3	10.5
4	242	2.7	29.3	23.4	16.8	40.4	10.1	29.2	27.1	6.9
Highest quintile	202	2.5	17.8	25.2	17.2	41.4	9.9	39.5	44.0	10.2
Area Residence										
Nukualofa										
Lowest quintile	78	0.7	34.6	33.9	12.5	38.5	7.4	42.3	39.7	7.4
2	82	0.7	27.7	40.2	17.2	44.1	6.6	47.6	44.0	5.3
3	91	0.8	16.9	37.4	10.0	53.2	4.0	55.4	52.3	2.8
4	114	0.9	21.8	37.8	9.0	57.3	2.8	49.3	54.4	2.1
Highest quintile	114	1.1	19.4	37.4	4.2	54.5	1.8	58.2	65.7	2.7
Tongatapu rural										
Lowest quintile	93	1.5	38.9	25.1	18.2	30.3	7.2	32.2	33.8	8.3
2	110	2.0	34.1	21.1	17.2	32.2	9.5	30.9	34.9	8.5
3	113	1.9	24.2	23.5	12.1	43.7	10.3	37.1	38.3	8.2
4	88	1.7	28.9	24.1	15.4	47.9	9.5	24.4	27.3	5.9
Highest quintile	75	1.6	17.9	21.4	11.4	44.8	8.9	38.3	43.7	6.6
Other rural										
Lowest quintile	250	1.5	33.6	25.6	38.1	16.9	22.4	20.3	18.0	22.2
2	170	0.9	28.4	22.3	36.2	20.8	19.9	17.3	22.4	21.8
3	144	0.9	37.4	22.3	29.1	13.7	19.3	25.4	17.5	16.2
4	154	0.9	30.2	21.9	19.9	23.9	11.2	39.7	26.6	9.0
Highest quintile	127	0.9	17.4	33.3	29.8	34.1	12.1	41.9	44.5	17.9

Annex 8. Share of animal protein in total protein

	Number of sampled households	Number of represented households ('000s)	Proportion of animal protein in total protein consumption (%)
Tonga	1,803	18.0	54.3
Quintiles of income			
Lowest quintile	421	3.6	52.4
2	362	3.6	52.6
3	348	3.6	55.8
4	356	3.6	56.4
Highest quintile	316	3.6	56.1
urban and rural areas			
Urban	479	4.1	59.2
Rural	1,324	13.9	52.9
Category for the size of the household			
Between 1 and 3 household members	426	4.6	51.0
Between 4 and 6 household members	743	7.3	54.0
More than 7 household members	634	6.1	55.2
Gender of the head of the household			
Male	1,442	14.1	54.1
Female	361	3.9	55.2
Categories for the age of the head of the household			
Less than 45	603	6.2	53.0
Between 45 and 59	588	5.7	55.9
More than 60	612	6.1	54.1
Area Residence			
Nukualofa	479	4.1	59.2
Tongatapu rural	479	8.8	55.6
Other rural	845	5.1	47.4

Annex 9. Food consumption by food commodity groups

Food group	Average edible quantity (g/capita/day)	Average food consumption in monetary value (T\$/capita/day)	Average dietary energy consumption (kcal/capita/day)	Contribution of food groups to total calories consumed (%)
Cereals and products	183.1	0.7	637	22%
Roots and tubers	622.0	0.8	828	29%
Sugars and syrups	38.2	0.1	151	5%
Tree nuts	1.7	0.0	11	0%
Vegetables and products	83.0	0.3	27	1%
Fruits and products	188.3	0.3	200	7%
Stimulants	6.5	0.0	23	1%
Spices & additives	8.8	0.0	19	1%
Alcoholic beverages	11.0	0.2	11	0%
Meat	178.3	1.4	377	13%
Eggs	5.9	0.1	8	0%
Fish and fish products	100.4	0.6	126	4%
Milk and cheese	28.9	0.1	20	1%
Vegetable oils and fats	7.2	0.1	59	2%
Oils and fats	9.1	0.1	69	2%
Non alcoholic beverages	95.7	0.2	50	2%
Purchased food eaten away from home; miscellaneous and prepared food	36.1	0.5	257	9%

N/A: very low or no nutrient content or no consumption

Edible quantities: food quantities adjusted by edible portions (e.g. eighty eight percent of an egg is edible). The edible quantities are not expressed in grams of primary commodities (e.g. the primary commodity of flour rice is grain rice); they correspond to the amount of edible quantity as consumed by households

Population intake goal of fruits and vegetables: at least 400 grams per person per day

Annex 10. Food consumption by food commodity group and food sources

	Purchases			Own Production		Food consumed away from home		Other sources	
	Contribution to the total diet (%)	Average dietary energy consumption (kcal/capita/day)	Share in food commodity group's total consumption (%)	Average dietary energy consumption (kcal/capita/day)	Share in food commodity group's total consumption (%)	Average dietary energy consumption (kcal/capita/day)	Share in food commodity group's total consumption (%)	Average dietary energy consumption (kcal/capita/day)	Share in food commodity group's total consumption (%)
Total									
Roots and tubers	29%	230.8	39	476	47	0	0	121	14
Cereals and products	22%	596.5	95	0	0	0	0	40	5
Meat	13%	342.6	91	2	1	0	0	33	9
Purchased food eaten away from home;miscellaneous and prepared food	9%	245.5	94	1	1	159	47	10	6
Fruits and products	7%	72.3	40	102	48	0	0	26	13
Sugars and syrups	5%	138.4	93	0	0	0	0	13	7
Fish and fish products	4%	81.1	74	15	7	0	0	30	19
Oils and fats	2%	67.2	98	0	0	0	0	1	2
Vegetable oils and fats	2%	55.2	96	0	0	0	0	4	4
Non alcoholic beverages	2%	49.3	95	0	0	0	0	1	5
Vegetables and products	1%	18.4	74.2	6.3	19.5	0.0	0.0	2.4	6.3
Stimulants	1%	23.3	97.1	0.0	0.0	0.0	0.0	0.1	2.9
Milk and cheese	1%	18.9	96.1	0.0	0.0	0.0	0.0	0.9	3.9
Spices & additives	1%	17.2	97.9	0.8	1.0	0.0	0.0	0.9	1.1
Alcoholic beverages	0%	10.7	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Tree nuts	0%	9.8	92.0	0.1	1.5	0.0	0.0	0.8	6.5
Eggs	0%	7.2	96.4	0.0	0.2	0.0	0.0	0.3	3.5

Annex 11. Process of the food data collected in the 2015/16 HIES of Tonga

This annex describes briefly the main steps that were followed to analyze the food data collected in the 2015/16 HIES of Tonga.

1- From the diary we selected the food purchased, food consumed from own production and food received for free and from the recall section of the questionnaire we selected information on expenditures on alcohol and restaurants.

2- Quantities of food were reported in 33 different units of measurement corresponding to about 4764 different combinations of food products and units of measurement. Less than 30% of the units were corresponding to standard units, for the other units it was necessary to find for each combination of product and unit a conversion factor.

When available conversions were derived from market information provided by the Ministry of Agriculture and ad-hoc information was gathered in the main market of Nuku'alofa.

The conversion of the 22% remaining quantities was performed using the median price of one standard unit of product for each zone

3- Extreme values were identified using the robust outlier detection method of the inter quartile range (IQR) applied on the quantity per person of each product (we used a 2IQR which identified as extreme values 1.5% of quantities out of 81000 quantities). Extreme quantities at low and upper bounds of the distribution of each product were replaced by the median quantity per person of that product by strata.

4- Nutrient values were associated to each edible quantity converted into gram²⁴ using the Pacific Nutrient Database developed jointly by SPC and Wollongong University.

5- Whenever the food consumed away from home was not well described (for instance “take away food”) and the nutrient value of the food consumed away from home was not available, energy content of the food consumed away from home was estimated using the median cost by region and income quintile of one calorie consumed in the house.

²⁴. Edible quantity corresponds to the quantity as reported to which a refuse factor to remove non edible portion of the food was applied.

6- Income distribution as estimated by SPC was used as welfare indicator to rank the distribution of household average dietary energy consumption per person per day. Table below shows that the average total consumption expenditures per capita (as estimated by the World Bank and used in the poverty analysis) are slightly lower than the average income per capita are slightly higher for the first three income decile. This means that using one distribution or the other as welfare indicator to categorize household and estimate the inequality in accessing energy due to income leads to different inequalities²⁵ results. In the case of Tonga we used the income distribution as it is not biased by excess variability that exists in occasional food expenditures that may be observed in case of acquisition surveys.

Table Annex 11.1. Distribution of per capita total consumption expenditures and per capita income

	Number of sampled households	Average total consumption in monetary value (T\$/capita/day)	Average income (T\$/capita/day)
Income decile			
1	221	6.68	3.64
2	200	8.27	6.42
3	193	9.30	8.36
4	169	10.04	10.34
5	172	10.60	12.50
6	176	12.58	14.97
7	176	14.99	18.12
8	180	16.36	23.18
9	155	21.26	31.30
10	161	32.08	69.26

7- The age sex structure that is needed in the estimation of the minimum and average dietary energy requirements as well as median heights were taken from the survey.

As already mentioned, the survey was not designed to perform food security analysis and therefore results may need to be considered with cautious and not taken at face value. Among the main limitations were:

- Use of an opened list and coding of the food items might not have been well performed at the field level (same code associated to different food product or different codes to same food products).
- The huge number of local unit of measurement. Conversion of not processed food product could be performed using market information but conversion of processed food was not easy to obtain and whatever considered as the most appropriate was used.

²⁵. A difference of 10 percentage points between CV of DEC due to total consumption expenditures and CV of DEC due to income.

- The food consumed away from home was collected in the diary and expenditures in bars and restaurant were collected in a different section of the questionnaire. It is believed that food consumed away from home might have been underreported. Especially in Nukualofa.
- It is also not certain at which level the survey is representative which questions the reliability of the prevalence of undernourishment estimate at a certain disaggregated level.
- As a proxy for number of people who shared the food information on usual residents plus visitors was considered but still this was provided as a rough estimate.
- Finally and not the least, the survey is a mixed survey reporting both on acquisition and consumption. Some food might have been acquired in bulk to be consumed after the fourteen days of the reference period or reverse some food may have been consumed out of stocks. The sample might not be big enough for the stock variation to be null on average. Also a lower dietary energy consumption was observed on the second week compared to the first week that could be attributed to a certain effect of fatigue while filling the diary. But this effect is more difficult to assess in an acquisition survey (as household may buy in bulk on the first week to be consumed in the week after and in such case do not report any acquisition on the second week).