Food and Agriculture Organization of the United Nations

Dietary patterns of households in Samoa

Identifying the factors and food items most important to understanding nutrition

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Acronyms

ADER	Average Daily Energy Requirement
AME	Adult Male Equivalent
BMI	Body Mass Index
CBN	Cost of Basic Needs
EA	Enumeration Area
EP	Edible Portion
FAO	Food and Agriculture Organisation
FBS	Food Balance Sheet
FPL	Food Poverty Line
HIES	Household Income and Expenditure Survey
MDER	Minimum Daily Energy Requirement
NCD	Non-Communicable Disease
NDS	Nutritional Dietary Surveys
PAL	Physical Activity Level
PIC	Pacific Island Country
RDI	Recommended Daily Intake
RNI	Recommended Nutrient Intake
SBS	Samoan Bureau of Statistics
STEPS	STEPWise approach to surveillance
UL	Upper Limit
WHO	World Health Organisation

Executive Summary

Improving the availability of lower cost, nutritionally superior diet has been identified as critical to improving food security, and health, in the Pacific.[1] Identifying the household and environmental factors contributing most to poor dietary outcomes, and the food items and quantities required for a nutritious diet, will assist policy-makers in this region to design targeted interventions to improve the cost and level of access at which households can access an improved diet.

This paper uses empirical methods to identify households most at risk of poor nutrition outcomes in Samoa, using microdata from the Household Income and Expenditure Survey (2013). It first establishes the average daily intake levels of energy and micronutrients among households in Samoa, and compares these with recommended intake levels using heat maps and tables to illustrate districts and household factors which face particular nutrition challenges. Using Ordinary Least Squares (OLS) regression analysis, it investigates whether dietary intake of these micro and macronutrients is positively or negatively correlated with indicators of income and food poverty identified in the literature on Pacific populations, and among populations where the majority of households are rural and engaged in semi-subsistence agricultural production: the age of the household head; the gender of the household head; the size of the household; whether or not the household is located in a more remote rural location or an urban area; and the income level and wealth assets enjoyed by the household. The paper also tests a new potential variable impacting on household food and nutrition intake: household expenditure on 'gifts' to other households, and to the Church. The paper also examines the average household food baskets, and the food baskets of households identified as having access to, or failing to access, the recommended micro and macronutrient intake levels. Finally, this paper identifies the optimum food basket for assisting households meet the recommended energy and nutrient dietary intake levels at the lowest cost.

This study estimates that the energy requirements for maintenance of current body weight at current average physical activity levels (determined by the main economic activity reported by all household members aged 15+) and basal metabolic requirements of a Samoan adult male (using the average adult male weight reported in the 2013 STEPS survey[2]), is 3 669 Calories. This intake level may not represent the 'desirable' energy intake among health advocates seeking to encourage a reduction in average body weight; yet, 3 669 calories represents the average daily energy requirement among a population with a high average adult male weight, and among whom farming – an activity which is labour intensive – is the main activity of the greatest number of respondents.

This study finds that average (adult male equivalent) Samoan has access to 3 509 Calories per day – slightly less than the average number of calories required to meet the average physical activity levels and anthropomorphic requirements of a Samoan adult male. The study finds that the average Samoan has access to: an insufficient amount of vitamin A; an excessive amount of sodium; protein and iron

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[1] Pacific Islands Forum (2011) *Op. Cit.*

[2] WHO (2014) Samoa: STEPwise approach to NCD risk factor surveillance report, Manila: WHO

which meets the recommended daily intake levels; and fat which does not exceed the maximum recommended intake (as per cent of energy).

The study finds that female headed households, and households located in the bottom income tercile (33%) are less likely to satisfy all the minimum and maximum micro and macronutrient thresholds associated here with an adequate diet; while households who enjoying a higher score on the wealth index, are slightly more likely to satisfy all these nutrition requirements. The study also finds that households where the head has a higher level of education, have a greater number of members, are located in the bottom income tercile, have a higher wealth index score, and have a share of gift expenditure in total household expenditure which is above the mean, are more likely to have access to fewer total calories; while households on Savaii are likely to have access to more calories. Households with a greater number of household members, who are in the bottom income tercile and whose rate of expenditure on gifts is above the mean, have access to a lower rate of intake of protein, fat, iron, vitamin A and sodium. Households with older household heads, and more educated household heads, have access to lower intake of protein and iron; though households with more educated heads of household, have access to far lower intakes of sodium. Households located on Savaii have access to higher intake of iron than households in Apia; while households enjoying a higher wealth index score, have access to a lower sodium intake, as well as slightly less iron.

This study shows that the minimum cost of a diet which meets the food and nutrition needs of households – including their recommended calorie, protein, fat, sodium, vitamin A and iron intake, as well as providing their recommended intake of total dietary fibre, vitamin C and E, and the recommended share of food energy from carbohydrates - is more expensive than the food poverty line (FPL) established for Samoa in 2015. This study found that purchasing an 'optimum food basket' would cost US$3.23 per person (Adult Male Equivalent) per day, whilst the FPL was determined to be US$2.17[3] per person per day. Therefore households whose level of income places them above the established national FPL may not have sufficient income to provide their family with an adequate diet.

The optimum food basket selected quantities of 6 food items identified as the most efficient for assisting Samoan households to obtain an adequate diet: taro, chicken pieces, bread, pumpkin, canned mackerel (eleni), coconuts (popo). This study shows that local food items (taro, pumpkin, and coconut) contribute US$1.35 of the cost of the optimum food basket, and therefore are able to be own produced to assist households to obtain the required macro and micronutrient intake levels.

Given households are falling far short of their required vitamin A intake levels and consuming far in excess of the required sodium levels, this study recommends further intervention by national policy-makers to influence household purchasing and consumption behavior, in order to improve nutrition outcomes. This study finds that reducing the price of local fruit, vegetable and animal products (particularly pawpaw and chinese cabbage) identified as good sources of vitamin A, would help to reduce the current deficiencies in daily intake among the Samoan population. Increasing consumption of

[3] UNDP (2015) *Samoa: A report on the estimation of basic needs poverty lines, and the incidence and characteristics of hardship and poverty – analysis of the 20013 Household Income and Expenditure Survey*, UNDP Pacific Centre and Samoan Bureau of Statistics, Suva

these items by substituting them in for the current major sources of vitamin A in average Samoan household diets – particularly canned mackerel (eleni) - would also help to reduce average sodium intake levels below the current high levels. This could be achieved through investments in improving the efficiency of production and marketing, supplemented by targeted food voucher schemes for at risk households and school feeding programmes. In addition, creating a more enabling environment to facilitate investment in improving the efficiency of local food production and distribution systems will be critical to reducing the cost of nutritious food for the wider Samoan population, in the long run.

This study also recommends that working with manufacturers to reduce the sodium content of bread and aiming to source canned food with lower sodium content - with a focus on mackerel - would help to reduce household sodium intake. Encouraging households to reduce the addition of table salt and sugar to meals and beverages would also significantly reduce calorie, fat and sodium intake levels. Fortifying flour, rice and milk products with micronutrients such as Vitamin A could help to increase intake levels of these important micronutrients. Finally, applying an excise on food and beverage products high in sodium, sugar or fat, could assist to disincentivise consumption and the revenue used to invest in improving access to healthier substitute products.

This paper is organized as follows: chapter 1 provides an introduction to the measurement of household food and nutritional security in Samoa, and the Pacific; chapter 2 explains the statistical method employed to identify the recommended and actual daily intake levels of Samoan households, using the 2013 Household Income and Expenditure Survey; chapter 3 presents descriptive tables supplemented by maps of Samoa at district level, providing an overview of the intake levels of households with different characteristics; chapter 4 presents the results of the OLS regression analysis identifying the correlation between nutrient intake of and the various household factors, in order to identify those most factors most important to explaining the failure to meet the recommended nutrition values; chapter 5 presents the most important food items and food categories in the diet of Samoan households, as well as for each household type; chapter 6 presents optimal basket of food items - defined as the lowest total cost basket of food items required to reach the recommended threshold of energy and nutrition consumption; and chapter 7 briefly discusses the policy implications of these findings, including possible interventions which could improve nutrition outcomes in Samoa. Additional descriptive and methodological information is provided in the Annexes.

Introduction

1.1 The impact of the triple burden of malnutrition on household welfare in Samoa

Samoa has been identified as facing a health epidemic of rising disability, suffering, and early deaths, caused by escalating rates of Non-Communicable Disease (NCDs).[4] NCDs, principally cardiovascular diseases, diabetes, cancer and chronic respiratory diseases, are the leading causes of death and disability in Samoa, and responsible for between 75 and 80% of deaths.[5]

The overall prevalence of obesity in Samoa was estimated to be 63.1%, with 89.1% of the population estimated to be overweight.[6] In addition, the adult (25-64 years of age) diabetes rate rose from 22.3% in 2002, to 45.8% in 2013.

Gradual tariff liberalisation has helped to reduce the cost of imported foods relative to locally produced substitutes, which may link directly to health conditions of the Samoan population.[7] Popular imported foods include off-cuts of meat and processed meat products, in addition to convenience food items, which contain higher fat and sodium contents than locally produced substitute foods have become cheaper over time, increasing the incentives for their consumption, which may therefore explain the sharp increase in obesity observed in Samoa over recent decades.[8]

However malnutrition is also a recognized problem in Samoa, with wasting (4%) stunting (5%) identified among the under-5 population.[9]

These results indicate that significant undernourishment and perhaps micronutrient deficiencies co-exist with high rates of excessive macronutrient and sodium intake. Identifying the characteristics of which households suffer from micronutrient deficiencies and those experiencing high macronutrient and sodium intake, is essential to inform targeted policy interventions which are effective for the Samoan population at large. As a result, micro and macro nutrient intake levels should be undertaken at a household level to develop accurate profiles for these at risk populations.

[4] Op. Cit WHO (2014)
[5] Ibid
[6] Ibid
[7] Fa'alili-Fidow J, McCool J, Percival T. (2014) Trade and health in Samoa: views from the insiders. *BMC Public Health* 14: 309
[8] Friel S, Labonte R, Sanders D. (2013) Measuring progress on diet-related NCDs: the need to address the causes of the causes. *The Lancet* 381(9870):903–904
[9] Samoan Bureau of Statistics (2014) *Samoa demographic and health survey*, Government of Samoa: Apia

1.2 The importance of developing evidence-based policy interventions for improving food and nutritional security outcomes in the Pacific context

Household diets and nutrition are of increasing importance to health, agriculture and economic policy-makers worldwide. The triple burden of malnutrition - undernourishment, micro-nutrient deficiencies and overweight/obesity - result in significant social and economic costs in both developing and developed countries. [10] An estimated 12.5% of the world's population is undernourished, whilst 26% of the world's children are stunted and 2 billion people suffer from one or more micronutrient deficiencies[11]. Micronutrient deficiencies, such as physical and cognitive impairment resulting from iron-deficiency anaemia and vitamin A deficiency, impose significant costs on society and act as a significant drag on economic growth in many developing countries.[12]

However, whilst under consumption of dietary energy, protein and micronutrients is still a problem for hundreds of millions of people, rising incomes and increased trade liberalization in the developing world is fuelling a food consumption transition which is contributing to weight gain and obesity.[13] More than 500 million people in the developing world are now obese. The impact of this trend has major implications for health and agriculture, and requires considered intervention in order to design policies which effectively incentivize healthier food choices.

While obesity rates have risen, worldwide, over the last three decades, the greatest and most significant increase has occurred in PICs.[14] Five of the world's ten most overweight nations are now in the Pacific Islands, where obesity rates regularly surpass 60%.[15]

In recent decades, the nations of the Pacific Islands have gone through a nutrition transition associated with the increased consumption of food high in fat and sodium; [16] migration to urban centres;[17] and

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[10] FAO (2013) *The State of Food and Agriculture: Food systems for better nutrition*, Rome: FAO
[11] Ibid
[12] Ibid
[13] Popkin. B, Adair. L, Ng. S, (2012) "Global nutrition transition and the pandemic of obesity in developing countries," Nutrition Review 70:3-21
[14] Finucane M., Stevens G. Cowan M., *et al.* 2011. "National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants." *The Lancet* 377: 557-67.
[15] Murray, C. Ortblad. K, Guinovart C, *et al.* (2014) "Global, regional, and national incidence and mortality for HIV, tuberculosis, and malaria during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013," The Lancet 384(9947) 1005-70
[16] Popkin. B, Adair. L, Ng. S, (2012) "Global nutrition transition and the pandemic of obesity in developing countries," *Nutrition Review* 70:3-21
[17] UNESCAP (2011) "People," Chapter 1 in *Statistical Yearbook for Asia Pacific*, United Nations Economic and Social Commission for Asia and the Pacific, Bangkok, Thailand

diversification of income generation away from primary sector activities.[18] These trends have contributed to an alarming rate of increase in diet and nutrition related disease.[19]

In 2011, the Pacific Island Countries (PICs) were declared to be in an 'NCD Crisis' with the region experiencing growing levels of premature deaths and preventable morbidity and disability from NCDs, principally as a result of rising rates of heart disease and diabetes. Obesity and diet based Non-Communicable Diseases (NCDs), like late onset (type II) diabetes and heart disease, are now at critical levels in many Pacific Island nations - leaving escalating health care costs, morbidity and mortality in their wake.[20] These factors led the Pacific Island Forum leaders to acknowledge that: "*NCDs already undermine social and economic development in the Pacific, and are financially unsustainable. NCDs impose increasingly large, yet often preventable financial costs on national budgets and the economy more broadly."*[21]

At the same time, Pacific Island Countries are making progress at reducing the proportion of the population that is undernourished. Several countries have already reduced the proportion of the population that is undernourished to less than 5%: Fiji, French Polynesia, New Caledonia and Samoa. However the percentage of underweight children is still at high levels in Papua New Guinea and the Solomon Islands.[22] Micronutrient deficiencies remain pervasive in the region, in particular vitamin A, Iron and iodine deficiency, which are strongly associated with childhood morbidity and mortality.[23] However, lack of data is an issue in several countries. Better data is urgently needed in order to better inform policy-making.[24]

Improving nutrition and reducing these costs must begin interventions to promote improved diet among at risk populations. This has prompted policymakers to explore broad-based approaches to analyzing the key household factors associated with poor nutrition and towards developing the targeted policy tools necessary to improve diets and health outcomes.

1.3 Identifying the causes of hardship and food poverty in the Pacific

Poverty measurement in PICs has been based on the Cost of Basic Needs (CBN) approach. The CBN approach is a commonly used method that attempts to define the minimum resources needed for long-

[18] UNESCAP (2008)"Unequal Benefits of Growth – Agriculture Left Behind," Chapter 3 in *Economic and Social Survey of the Pacific*, United Nations Economic and Social Commission for Asia and the Pacific, Bangkok, Thailand

[19] Pacific Islands Forum (2013) Towards Health Islands: Pacific Non-Communicable Disease Response, 10th Pacific Health Ministers Meeting, Apia, Samoa

[20] Finucane. M, Stevens. G, Cowan. M, *et al.* (2011) "National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants," The Lancet 377:557-67

[21] Pacific Island Forum (2014) *Op. Cit.*

[22] FAO (2014) *State of Food and Agriculture in the Asia-Pacific Region*, Bangkok: FAO Regional Office for Asia-Pacific

[23] Black, R.E., *et al*., *Maternal and child undernutrition: global and regional exposures and health consequences.* The Lancet, 2008. 371(9608): p. 243-260.

[24] FAO (2014) *Op. Cit*

term physical well-being, usually in terms of consumption.[25] Using this approach, a poverty line is defined as the amount of spending required to obtain a basket of food and non-food goods considered to meet the "basic needs" of households in that country.[26] The basic needs of a household are estimated from the cost of a minimally-nutritious, low-cost diet which delivers a minimum of around 2100/2200 calories (Kcal) per average adult per day, rather than the recommended intake levels for both micro and macronutrients.[27] The daily values of food poverty lines using the CBN approach vary substantially across countries in line with national income levels: from below US$1.25 per person a day in the Solomon Islands to US$2.17 in Samoa.[28]

Previous investigations of household level poverty and hardship in the Pacific Islands have identified a number of critical factors which increase poverty, including location, the gender of the household head, the size of the household, the education level of the head of household, and the level of household income and wealth.[29]

Households headed by individuals who have limited education, or by the elderly, or with more children to support, are more likely to live in hardship than households headed by more educated or younger people.[30] Households headed by women have been shown to have both a lower likelihood, and increased likelihood, of hardship among PICs.[31]

Households headed by women may make different food choices, or access to different income levels, which may affect the dietary intake of members of these households. Households headed by females have been found to be more likely to consume fruit and fiber, while limiting salt and fat intake.[32]

Households with more children are also more likely to live in hardship, as is observed in most countries around the world.[33] As a result of dividing available food resources between an increase number of household members, the ratio of household members dependent upon members generating an income has a large impact on nutrient intake levels.

The incidence of poverty and hardship is higher for households headed by persons aged 65 and over, compared to the national average.[34] However there are significant differences in the rate of hardship

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[25] Haughton and Khandker (2009) *Op. Cit*.
[26] Ibid
[27] UNDP (2010) *Report on the estimation of Basic Needs Poverty Lines, and the incidence and characteristics of hardship and poverty*, Suva: UNDP Pacific Centre
[28] Based on average 2013 exchange rate of 1 US$=WST2.2691, provided by Oanda http://www.oanda.com/currency/historical-rates/ accessed on 30/10/2015
[29] World Bank (2014) *Op. Cit.*
[30] Ibid
[31] Ibid
[32] Jane Wardle et al., "Gender Differences in Food Choice: The Contribution of Health Beliefs and Dieting," *Annals of Behavioral Medicine* 27, no. 2 (April 1, 2004): 107–16, doi:10.1207/s15324796abm2702_5; I. Elmadfa, *Diet Diversification and Health Promotion* (Karger Medical and Scientific Publishers, 2005).
[33] World Bank (2014) *Op. Cit.*
[34] Ibid

across the PICs. These differences across countries are likely to be related to traditional social insurance systems designed to support the elderly.[35]

There has been international evidence for structural differences in the nutritional status of urban and rural households. [36] While most Pacific islanders in rural areas have access to and practice subsistence agriculture or aquaculture, obtaining at least some of their households' food from cultivated gardens, wild vegetation, and the ocean, [37] households located in small villages in remote locations are often exposed to higher transport costs which drives up input prices and reduces income derived from traded goods.[38] Therefore rural location is seen as both a source of income security and a limit upon household income growth. While urban populations are able to access formal and informal employment not always available in rural areas, urbanization has also acted to reduce access to land for subsistence among urban populations, putting a strain on traditional social safety nets. [39] This appears to imply that there is no one-size-fits-all nutrition policy for urban and rural areas, and the effect of urbanization will be analyzed as a part of this study.

Households that are able to access higher income are subject to lower rates of hardship and poverty, given their increased resilience to shocks and their capacity to meet rising demand for consumption expenditure.[40] Households in the lowest one or two income quintiles often access a minor share of total consumption. As households shift from income dependence upon subsistence production to income from cash crops and off-farm employment, they may derive additional resilience from supplementing or substituting own produced food items with purchased food items. However this transition may have a significant impact on diet and nutrient intake.

Transfers of 'gifts' of food, cash and labour between households within traditional networks have been observed to both place considerable strain upon the productive resources of households[41], and increase the resilience of households to income shocks[42]. Interwoven with these traditional networks, churches provide various forms of support to their members; yet they also require substantial commitments of time and money.[43] In particular, demand for support to ceremonial events and communal activities

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[35] Ibid

[36] Anne Hatløy *et al.*, "Food Variety, Socioeconomic Status and Nutritional Status in Urban and Rural Areas in Koutiala (Mali)," *Public Health Nutrition* 3, no. 01 (March 2000): 57–65, doi:10.1017/S1368980000000628.

[37] WHO (2010) "Pacific Islands Pay Heavy Price for Abandoning Traditional Diet." *Bulletin of the World Health Organization* 88: 484-485

[38] Winters, A. and P. Martins (2004) "When Comparative Advantage is Not Enough: Business Costs in Small Remote Economies." *World Trade Review* 3 (3): 347-383

[39] World Bank (2013) *Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience,* Washington, DC: World Bank.

[40] Ibid

[41] Gibson, J. (2006) "Are there holes in the Safety Net? Remittances and Inter-household transfers in Pacific Island Economies," Working Paper 1, Pasifika Interactions Project, Wellington, New Zealand

[42] Ratuva, S. (2010) "Back to Basics: Towards Integrated Social Protection for Vulnerable Groups in Vanuatu," *Pacific Economic Bulletin* 25(3): 40-63

[43] Barker (1996) "Winds of change (Review)," *Contemporary Pacific* 8(1): 234-36

(including Churches) may represent a more significant burden for households at lower income levels and have an impact on diet and nutrient intake.[44]

1.4 The advantages of using Household Income and Expenditure Surveys to identify risk factors associated with insufficient nutrition and develop targeted policy response

A more detailed overview of the different survey tools and methods used to calculate malnutrition and dietary insufficiency, and the advantages of using HIES for this purpose in the Pacific, is provided in Annex 2. However, among the advantages of using HIES for investigation household nutrition are:

a) Sample unit: given that food insecurity manifests itself at household and individual levels, and the data on food expenditures are collected directly from households themselves, data produced by a HIES are likely to be more reliable than those derived from data collected at more aggregate levels.
b) Sample size: between 5 and 10 per cent of households participate in a HIES – a far larger dataset than many of the other health and nutrition surveys currently implemented in the Pacific
c) Time period covered by the data: The household food expenditure information collected from households through the HIES covers a 2-week period; whilst the enumeration of households is staggered over a 12-month period. This approach captures a better insight into changes in diet/consumption patterns within the household than a more limited time period like a 24-hour recall method; as well as capturing changes in diet caused by seasonality (food price change and availability)
d) Complementary data: the HIES collects complementary demographic and income information which can be used to identify and describe who is food insecure. This information also enables policy makers to examine food security outcomes within-country, at regional and household levels,
e) Regional coverage: Household Income and Expenditure Surveys (HIES) have been adopted by National Statistics Offices throughout the Pacific region over the last two decades, with 16 HIES having been conducted since 2006 (and another 6 to be implemented in the next 3 years). 9 PICs have now conducted 2 or more HIES, providing an opportunity for comparisons both between countries and of change over time.

Some criticisms have been leveled at using household expenditure collected by a HIES to estimate consumption, including the inability of this method to account for:

a) Wastage: food items bought but not consumed by the household (considered to be lower in developing country contexts where food is purchased more frequently, due to lack of cold storage) [45]
b) Stocks: food items purchased in large quantities during the sample period, but not entirely consumed during this period. This is particularly relevant to purchases of grains (rice, wheat,

[44] Abbott, A. and Pollard, S. (2004) *Hardship and Poverty in the Pacific*, Manila: Asian Development Bank
[45] Calculations using FAO Food Balance Sheets http://faostat.fao.org

maize) which are far less important in the Pacific consumption context than for other regions, given the dependence on root crops for carbohydrates. However this may be more relevant for purchases of condiments such as table salt and soy sauce.[46] In this study, close attention has been made to the size of containers and packets most commonly associated with purchase of items, and repeat purchases within the diary period, in order to establish average consumption and hold for households where implied consumption is more than three standard deviations from the median. Future improvements in the HIES methodology may be able to account for stocks in order to more accurately estimate household consumption during the study period.

c) Intra-household distribution: food expenditure information is collected at a household level not an individual level, and therefore individual results are inferred. In order to more accurately infer individual consumption outcomes, this paper determines individual shares using a detailed process of calculating proportional shares for different age and sex categories, informed by international evidence (see Annex 3).
d) Inter-household transfers: inter-household contributions of food gifts, typically associated in the Pacific Islands with feasts and other ceremonies celebrating church and life cycle (wedding, funeral, chiefly rank) celebrations, are accounted for in the household income and expenditure diaries. However more attention could be paid to accurately capturing the impact of semi-regular inter-familiar feasting on food and nutrition intake levels.

There are methodological challenges to all empirical work. There are also significant challenges to enumerating accurate datasets in the Pacific Islands. Accepting these challenges and propensity for minor inaccuracies, using Household Income and Expenditure Surveys to estimate individual nutrition outcomes offers the Pacific Islands, and Samoa, a unique opportunity to improve the quality of empirical information available on the risk factors contributing to one of the great social and economic challenges of our time: how to limit rising obesity and NCDs without exacerbating the health issues associated with insufficient dietary intake, such as stunting and low-birth weight. This approach, therefore, provides policy makers with an important tool to better target interventions in the agriculture, education, health and trade sectors critical to improving nutrition in the Pacific Islands.

[46] Smith, L. (2007) The Use of Household Expenditure Surveys for the Assessment of Food Insecurity, Washington D.C: IFPRI

2. Using the Household Income and Expenditure Survey to identify household risk factors associated with poor nutrition outcomes in Samoa

2.1 Samoa (2013) Household Income Expenditure Survey data collection methodology

The 2013 Household Income and Expenditure Survey (HIES) was the fourth comprehensive survey of its type conducted in Samoa – the last having been undertaken in 2008. This survey collected demographic, income and expenditure information from 16,356 people living in 2791 households from all 4 regions and 48 districts across the Samoan islands. Each participating household kept a diary of the value and volume of all food expenditure (including subsistence, or food produced by the household) for a two week period. This expenditure information is able to be converted into a proxy of household food energy and nutrient intake - following the detailed methodology outlined in Annex 3, and in this section - in order to establish the nutrient and food energy values for each household member, by household type; and to identify the household factors most closely correlated with increased risk of poor nutrition outcomes. Using this information it is also possible to identify those food items which contribute most to positive and poor nutrition outcomes, in order to develop and adopt policy interventions appropriate to improving household nutrition in Samoa.

2.2 Samoa (2013) Household Income and Expenditure Survey results in brief

This survey identified that 79.1% of the population was living in rural and peri-urban areas, with only households living in the district of Apia (20.9% of the sample) identified as urban. On average, 5.9 people lived in each household. 19.4% of households were headed by a female. Each household supported an average of 3.4 dependents. Subsistence activities contributed 15.2% to total household income on average, while wages contributed 49.5%. Wages and salaries contributed 62.8% of household income for urban households, whilst contributing 43.5% for rural households. Subsistence income provided only 3.4% of income for urban households; whilst subsistence contributed a 20.5% share of total income in rural areas.

2.3 Average required daily energy requirement for the Samoan population

Determining the average daily energy requirement (ADER) of the Samoan population at current levels of body size and level of physical activity requires the identification of the metabolic energy requirements of an average Samoan, multiplied by the additional energy requirements associated with the physical activity level of the average Samoan. There may be differences between the actual energy requirements needed to maintain current body size and level of physical activity and the desirable energy requirements needed to maintain body size and levels of physical activity consistent with good health. Desirable energy requirements may be lower than actual requirements for people who are overweight or obese. However basing the national average energy requirement on the desirable energy intake of a sub-section of the population who may be obese runs the risk of under-proscribing the required intake

for those sections of the population with higher activity levels. For this reason, we calculated an ADER required at current levels of bodyweight and physical activity.

Humans need energy for basal metabolism which comprises a set of functions necessary for life such as cell metabolism, synthesis and metabolism of enzymes and hormones, transport of substances around the body, maintenance of body temperature and ongoing functioning of muscles including heart and brain function.[47] The amount of energy needed for this purpose is called the basal metabolic rate (BMR). There are differences between the actual energy requirements needed to maintain current body size and therefore the BMR, depend on age, gender, body size and composition of the subject.

The BMR energy requirements of individuals in Samoa can be calculated using the Schofield equation[48], after inputting for average weight. Unfortunately, average weight was not collected in the HIES. However the WHO STEPS survey, conducted in the same year as the HIES (2013), did collect the average weight of adult males and females, and therefore these can be used to calculate the BMR for these two age and sex categories. The 2013 STEPS Survey found that the average weight of a man aged 25-64 was 91.5kg, while the average height of a woman aged 25-64 was 158.7 cm and the average weight was 89.2 kg.[49] The average male and female adult weights can be inputted into a Schofield equation for men and women aged 18-30, and aged 30-60, to estimate the average BMR for adult males aged 18-65.In the absence of available/current weight information for other age and sex categories, this study estimated the energy requirements of each age and sex category as a set proportion of the adult male ADER, using the Average Male Equivalent method. The calculation of the energy intake requirements for each age and sex category using this proportional method is provided in more detail in Annex 3. Table 1 and 2 indicate the BMR for Samoan adult males and females, using average adult male and female weights.[50]

Table 1: Applying Schofield equation to adult male weights (Samoa 2013)

Male	**Schofield equation**	**BMR (kcal)**
18–30	15.057 × 91.5 + 692.2	2 069.9155
30–60	11.472 × 91.5 + 873.1	1 922.788
Adult Male (18-65) energy requirement		1 996.35

[47] National Health and Medical Research Council (2013) *Australian Dietary Guidelines*, NHMRC: Canberra
[48] FAO, WHO, and UNU (1985) Energy and Protein Requirements, Technical Report Series 724, Geneva: WHO http://www.fao.org/docrep/003/aa040e/aa040e00
[49] Op. Cit WHO (2014)
[50] Ibid

Table 2: Applying Schofield equation to adult female weight (Samoa 2013)

Female	Schofield equation	BMR (kcal)
18–30	14.818 × 89.2 + 486.6	1 808.3656
30–60	8.126 × 89.2 + 845.6	1 570.4392
Adult Female (18-65) energy requirement		1 689.4

Physical activity is the most variable determinant of energy need and is the second largest user of energy after BMR. Humans perform a number of physical activities including occupational and discretionary activities. However on average, the main additional requirements introduced by an individual's Physical Activity Level (PAL) come from occupational activities and therefore, occupation or 'main activity' can be used to estimate the amount of food energy needed to maintain a particular lifestyle, above the basal metabolic rate (Table 3).

Table 3: Physical Activity Level (PAL) Scores for different occupations and lifestyles

Activity description	Subject description	PAL Score
1. At rest, exclusively sedentary or lying (chair-bound or bed-bound).	Old, infirm individuals. Unable to move around freely or earn a living	1.2
2. Exclusively sedentary activity/seated work with little or no strenuous leisure activity	Office employees,	1.4–1.5
3. Sedentary activity/seated work with some requirement for occasional walking and standing but little or no strenuous leisure activity	Laboratory assistants, drivers, students, assembly line workers	1.6–1.7
4. Predominantly standing or walking work	Housewives, salespersons, waiters, mechanics, traders	1.8–1.9
5. Heavy occupational work or highly active leisure	Construction workers, farmers, forest workers, miners, high performance athletes	2.0–2.4

Source: Australian and New Zealand National Reference Values for Dietary Energy *http://www.nrv.gov.au/dietary-energy*

Determining the additional energy requirements associated with the Physical Activity Level (PAL) of the individual is calculated here using the 'main activity' reported for all respondents aged 15+ in the HIES. The 2013 HIES estimated the main activity of the 118,992 Samoans aged 15+. Using this information, it is possible to calculate a PAL, using the mid-range PAL value for each activity category (Table 4).

Table 4: Average Physical Activity Level (PAL) using HIES 2013 'main activity' information for members aged 15+

Activity category	Mid-range PAL	# individuals in category	# after application of PAL multiplier	National PAL (PAL multiplier individuals/# individuals)
1	1.2	6 189	7 426	
2	1.45	11 896	17 249	
3	1.65	34 948	57 664	
4	1.85	24 389	45 121	
5	2.2	41 570	91 454	
		118 992	218 914	**1.84**

Table 4 indicates the main activities of Samoan population, estimated from the 2013 HIES. This table indicates that the average PAL multiplier for Samoa is 1.84.

In order to find the ADER for adult males and females, the BMR rate is multiplied by the average PAL (Tables 5 and 6).

Table 5: Applying Schofield equation and PAL multiplier to determine adult male ADER

Men	Schofield equation	BMR (kcal)	PAL multiplier	ADER
18–30	15.057 × 91.5 + 692.2	2 069.9155	1.838	**3 805**
30–60	11.472 × 91.5 + 873.1	1 922.788	1.838	3 534
Adult Male (18-65) energy requirement		1 996.35	1.838	**3 669**

Table 6: Applying Schofield equation and PAL multiplier to determine adult female ADER

Women	Schofield equation	BMR (kcal)	PAL multiplier	ADER
18–30	14.818 × 89.2 + 486.6	1 808.3656	1.838	3 255
30–60	8.126 × 89.2 + 845.6	1 570.4392	1.838	2 827
Adult Female (18-65) energy requirement		1689.4	**1.838**	**3 105**

The ADER for each age and sex category of the Samoa population can then be calculated using the Adult Male Equivalent method (described in more detail in Annex 3). This is provided in Table 7. Table 7 indicates that the ADER for Samoan adult males is 3669 kcal.

Table 7: The Average Daily Energy Requirement for Samoa

	0 - 6 months	7 - 11 months	1 - 3	4 - 6	7 - 9	Male 10 -18	Female 10- 18	Male 19-65	Male 65+	Female 19-65	Female 65+
Calories (kcal)	539	863	1 138	1 521	1 791	2 941	2 291	3 669	2 465	3 105	2 092

2.4 Establishing macro and micronutrient RDI and UL for Samoa

A balanced diet is a diet that provides energy and all essential nutrients for growth and a healthy and active life. Since no foods contain all the nutrients required to permit the normal growth, maintenance, and functioning of the human body, a variety of food is needed to cover a person's macro- and micronutrient needs. Any combination of foods that provides the correct amount of dietary energy and all essential nutrients in optimal amounts and proportions is a balanced diet.[51]

To minimize the risk of nutrient deficit or excess, a joint FAO/WHO expert group defined the recommended dietary requirement for micro and macronutrients as an intake level that meets specified criteria for adequacy.[52] The Recommended Dietary Intake (RDI) is the daily nutrient intake level, plus two standard deviations, that meets the nutrient requirements of all nearly all (97-98%) of the "healthy" individuals in a particular age and sex group.[53] Therefore, to express nutrient requirements and recommended intakes for population groups, the requirements applied separately to each individual belonging to the population of analysis are summed.

There are a large range of micronutrients in food, including vitamins A, B12, C, D, E, K, calcium, iron, magnesium, potassium, sodium and zinc. As earlier identified, iron and Vitamin A deficiency are critical to avoiding health problems associated with poor diet, such as physical and cognitive impairment, and blindness.

Vitamin A is an essential nutrient needed in small amounts by humans for the normal functioning of vision, growth and development, maintenance of epithelial cellular integrity, immune system functioning, and reproduction.[54] High levels of Vitamin A are found in green leafy vegetables (e.g. spinach, Chinese cabbage and taro leaves), yellow vegetables (e.g. pumpkins and carrots), and yellow and orange non-citrus fruits (e.g. mangoes and papayas).

Iron has several vital functions in the body, including the transportation of oxygen to the tissues from the lungs by red blood cell hemoglobin.[55] The primary sources of iron are the hemoglobin and myoglobin from consumption of meat, poultry, and fish; in addition to from other forms (non-heme iron) from cereals, pulses, legumes, fruits and vegetables, such as taro.

Humans gain energy from breaking down four different macronutrients: protein, fat, carbohydrates (including fibre) and alcohol. Each macronutrient contributes to the total dietary energy but in different proportions e.g. 1 gram of protein contributes 4 calories, while fat contributes 9 calories and is, as a

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[51] Moltedo *et al.* (2014) *Op. Cit.*
[52] Ibid
[53] Ibid
[54] FAO and WHO (2004) *Vitamin and Mineral Requirements in Human Nutrition*, 2nd ed. Rome: FAO
[55] Ibid

result, more energy dense.[56] A joint WHO/FAO expert group established guidelines for a balanced diet, and found that a balanced diet exists when the following conditions are met:

- The proportion of dietary energy provided by protein is in the range of 10–20%
- The proportion of dietary energy provided by fats is in the range of 15–30%
- The remainder of dietary energy (50-65%) should be contributed by carbohydrates[57]

Because both under and overconsumption of sodium and fat is the cause of health problems, sodium and fat have a RDI and an Upper Limit (UL). While a minimum level of sodium intake is required to promote for cell function, excessive sodium intake leads to elevated blood pressure and increased risk of NCDs such as cardiovascular and kidney diseases, and diabetes. The United States Department of Agriculture and United States Department of Health and Human Services (2010) have established that the maximum amount of sodium that adults should consume in a single day – the safe UL - is 2300 mg of sodium, which is equivalent to 6 grams or 1 teaspoon of salt, per day[58]; while the WHO recommends a slightly lower figure of 2000mg or 5 grams per day.[59] In this study we use the higher figure to establish how many households are above the absolute Upper Limit for sodium consumption.

Adequate amounts of dietary fat are essential for health; yet given fat contains more than twice as many calories of energy per gram as carbohydrates and protein, excessive consumption of fat leads more quickly to weight gain, and associated health problems. A diet rich in saturated fats (oil products and fatty cuts of meat, such as corned beef and lamb flaps) raises cholesterol levels and risk for NCDs such as cancer,[60] diabetes,[61] and heart disease.[62] On average, individuals should not consume more than 30% of their energy from fat, particularly if it is high in saturated fatty acids which are derived primarily from animal sources.

The RDI values for protein, vitamin A and iron, and Upper Limits (UL) for fat and sodium are provided in Table 8, along with the ADER. The ADER is used to calculate RDI for protein, as well as the Upper Limits (UL) for fat, using the recommendation that at least 10% of energy intake should come from protein, and that no more than 30% of energy intake should come from fat.

[56] Ibid
[57] WHO and FAO (2002) Human Vitamin and Mineral Requirements, part of a joint FAO/WHO expert consultation, Bangkok: FAO
[58] U.S. Department of Agriculture and U.S. Department of Health and Human Services (2010) *Dietary Guidelines for Americans 2010*, 7th Edition, Washington, DC: U.S. Government Printing Office
[59] WHO (2007) Prevention of cardiovascular disease: guidelines for assessment and management of cardiovascular risk. Geneva, World Health Organization (WHO)
[60] World Cancer Research Fund/American Institute for Cancer Research (1997) *Food, Nutrition, and the Prevention of Cancer A Global Perspective*, World Cancer Research Fund/American Institute for Cancer Research, Washington, D.C., pp. 216–251
[61] Report of a Joint WHO/FAO Expert Consultation (2003) Diet, Nutrition and the Prevention of Chronic Diseases, WHO Technical Report Series 916
[62] Ibid

Table 8: Recommended Dietary Intake (RDI) and Upper Limit (UL) of key macro and micronutrients

	0 - 6 months	7 - 11 months	1 - 3	4 - 6	7 - 9	Male 10 -18	Female 10- 18	Male 19-65	Male 65+	Female 19-65	Female 65+
Vitamin A* RDI (µg/day)	375	400	400	450	500	600	600	600	600	500	600
Iron RDI (mg/day)**	0.2	11	9	9	10	11	14	8	8	18	8
Sodium UL (mg/day)	1 500	1 500	1 500	1 900	1 900	2 200	2 200	2 300	2 300	2 300	2 300
Protein RDI (g/day)	11	17	14	19	22	51	40	92	62	78	52
Total fat UL (g/day	36	58	44	51	60	98	76	122	82	104	70
Total ADER (kcal/day)	539	863	1 138	1 521	1 791	2 941	2 291	3 669	2 465	3 105	2 092

Source: WHO and FAO (2002) Human Vitamin and Mineral Requirements, part of a joint FAO/WHO expert consultation, Bangkok: FAO

* Vitamin A: Vitamin A values are "recommended safe intakes". This level of intake is set to prevent clinical signs of deficiency, allow normal growth, but does not allow for prolonged periods of infections or other stresses.

**Iron: The RDI was set by modeling the components of iron requirements, estimating the requirement for absorbed iron at the 97.5th centile, with use of an upper limit of 14% absorption for 1-3-year-olds and 18% for other ages, and rounding; and an upper limit of 10% absorption, and rounding for babies aged 7-11 months. The RDI for 0-6 months was calculated by multiplying the average intake of breast milk (0.78 L/day) by the average concentration of iron in breast milk (0.26 mg/L), and rounding

*** Protein: The RDI was established based on 10% of dietary energy coming from protein for an daily kcal intake of 2200

****Fat: The UL was established based on 30% of dietary energy coming from fat for an average daily kcal intake of 3040

2.5 Estimation of nutrition levels per capita

The Samoan HIES collected consumption data at an aggregated household level. However, RDI, UL and ADER values are calculated on an individual bases using Adult Male Equivalent (AME) rates. A more detailed explanation of the methodology for calculating AMEs and the AME values used for each micro and macronutrient, for each age and sex category, is provided in Annex 3.

2.6 Establishing edible portions of fresh and unprocessed food items

In order to convert the 'as purchased' (AP) volume of fresh items commonly consumed in Samoa, to their edible portion (EP), following the methodology explained in Annex 3.

2.7 Descriptive tables of household factors and sub-populations

To understand variation in household level nutrient intake, descriptive statistics analysis was conducted on subsamples of the data, and the resulting tables and maps are provided in Chapter 4. This allows the study to compare nutrient intakes across different subpopulations within Samoa, or compare different kinds of households. More information on how these variables were constructed is provided in Annex 3.

2.8 OLS Regression analysis

Multivariate regression techniques are used to analyze how household factors are related to nutrition outcomes. With regressions, the study can better identify the effect of a given variable on nutrition outcome by controlling for potentially confounding factors. The outcome of this analysis is provided in Chapter 5. More information on the methodology to undertake this OLS regression analysis is provided in Annex 3.

In order to make the result of the modeling more robust across the 7 OLS regression equations, the study team undertook a series of measures. The impact of differences in household (age and sex) composition on household member intake is controlled for by reporting all intake figures in Average Male Equivalent (AME) Units. As a result, the size of the household is not included in the model as a separate independent variable.

A common concern when using multivariate regression analysis is multicollinearity amongst the independent variables used to generate the model. That is, magnitude of some coefficient estimates might be increased because of associations between predictor variables, resulting in misleading measurements of the strength of the association in question. To test if this was an issue in our model, we observed variance inflation factors that ranged between 1 to 2, well below the suggested cut-off value of 10 provided by Kutner *et al*., (2004). As such we concluded that multicollinearity was not an issue in our model.

The initial household sample set selected 2792 households, while only 2334 households provided a full set of responses to SBS. As a result, the study team constructed weights to mitigate attrition in the sample In order to improve the accuracy of the regression estimates. The regression model also clustered the results at village level in order to control for inter-cluster correlations. In order to reduce the impact of food consumption outliers, households whose calorie intake (per AME) placed them in the top and bottom 1% of AME calorie distribution, were removed from the model. This, further reduced the total number of households described in the following sections, from the original 2334 households, to 2282. Thus, counting for missing observations and after trimming the data to mitigate error in measurement in the quantity of food consumed, the sample reduced by 2%. The calculation of the attrition weights and a description of the kernel density differences prior to and following this 'trimming' of the household set, is provided in Annex 3.

2.9 Food Rankings

To identify important items in the typical food expenditure baskets of households in Samoa, this study produced rankings of foods. This study identifies which foods were most important as a proportion of household expenditure and nutrient intake type, for urban and rural households; and for households satisfying and not satisfying nutrient intake requirements. The outcome of this analysis is provided in Chapter 6. More information on the methodology to select these food baskets is provided in Annex 3.

2.10 Identification of an optimum food basket

One of the objectives of this study is to identify a low-cost bundle of food that meets all the daily recommended nutrient intakes, and the total cost of purchasing that bundle. To identify this optimum basket of food items at the lowest possible cost, we used linear programming. Linear programming is a mathematical optimization technique used to find a maximum or minimum of an objective function (such as cost minimization or profit maximization) that is subject to a set of linear constraints.[63] These constraints are most commonly expressed as inequality constraints that specify a minimum or maximum value for factors.

The optimization problem is then to minimize food expenditures by choosing a bundle of food items that collectively meet all the nutrient intake requirements for a healthy diet. The outcome of this analysis is provided in Chapter 7. More information on the methodology to select this optimum food basket is provided in Annex 3.

[63] Robert Dorfman, Paul A. Samuelson, and Robert M. Solow, *Linear Programming and Economic Analysis* (New York: Dover Publications, 1987).

3. Descriptive Tables

3.1 Differences in nutrient intake levels by region

Table 9: Difference in daily, per capita (AME) access to micro and macronutrients, by region

	Calories (kcal)	Fat (g)	Sodium (mg)	Protein (g)	Iron (mg)	Vit. A (ug)	Observations
Overall	3 509	96	2 903	127	18	433	2 286
Apia	2 725	101	3 082	122	11	517	483
NW Upolu	2 929	87	2 864	108	13	416	754
Rest of Upolu	4 438	99	2 979	149	27	441	505
Savaii	3 859	106	2 759	133	20	400	544

Table 9 indicates that average intake of Calories is 3 509 kcal, and that Calorie intake is lower in urban (Apia) and per-urban (NW Upolu) regions than in rural regions (Savaii and 'Rest of Upolu'). This finding is consistent with the higher proportion of household members aged 15 and over in rural areas who are engaged in farming as a main activity, and therefore who have higher energy intake requirements as a result of greater physical activity levels. Table 9 indicates that of the four regions, the average intake level is the lowest among members of households in Apia is (2 725 kcal) and highest among households located in the 'Rest of Upolu' region (4 438 kcal).

Table (9) indicates that fat consumption is lowest in the peri-urban region of NW Upolu, and highest in Savaii. Fat consumption in Apia is the second highest of the four regions, at 101 grams. This intake indicates that the level of fat consumption is, on average, higher than the recommended Upper Limit of 30% of total energy coming from fat - noting that there are 9 calories in every gram of fat, and therefore 909 kcal (or 33%)of Apia household total calorie intake of 2 725, coming from fat. Although fat consumption in Savaii is higher than Apia, the higher calorie intake (3 859) of households in this region means that total fat intake is below the recommended Upper Limit for households on Savaii, as well as households in other regions.

Average sodium consumption is highest among households in Apia (3 082mg), well above the recommended Upper Limit of 2600mg, per capita (AME) per day. Further, Table 10 indicates that average sodium consumption for all households, and households in each of the 4 regions, is above the recommended Upper Limit. This result indicates that sodium intake is an issue for national concern in Samoa.

Protein consumption is highest among households in the 'Rest of Upolu' region, and second highest in Savaii; whilst lowest in the peri-urban region of NW Upolu, and second lowest in Apia. These findings indicate that protein consumption is higher in the two 'rural' regions, compared to urban and peri-urban regions. However protein (containing 4 calories per gram) intake is above the recommended daily intake

(10% of total food energy) in each of the 4 regions. Table 10 indicates that access to sufficient protein intake is not a significant national problem in Samoa.

Table 9 indicates that average iron intake is lowest in Apia, (and next lowest in NW Upolu) and highest in the 'Rest of Upolu' region, then Savaii. Table 9 also indicates that average (AME) daily iron consumption (18mg) is well above the recommended daily intake for adult males (8mg), and that average intake in each of the 4 regions is also above the RDI. This indicates that households in Samoa are accessing a diet providing sufficient iron, on average.

However, the results for Vitamin A presented in Table 10 indicate that access to Vitamin A is a national issue. This Table indicates that on average, (AME) members of Samoa households access 433 micrograms (ug) of Vitamin A per day – below the recommended daily intake of 600ug. Further, Table 9 indicates that Vitamin A consumption is below the recommended level in each of the four regions, and is lowest on Savaii, and highest in Apia. These results indicate that improving access to Vitamin A is a national issue.

3.2 Maps of differences in nutrient intake by district

Figure 1: Map of per capita (AME) daily Calorie (kcal) intake by district

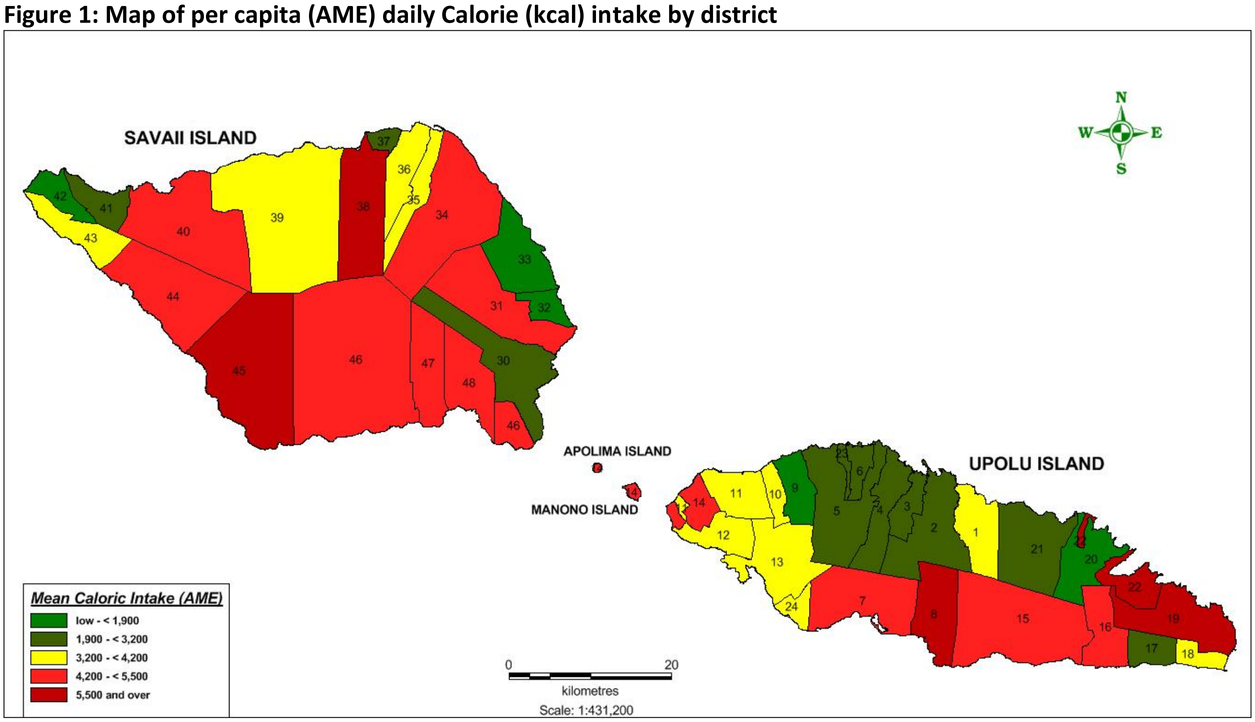

Figure 1 illustrates the diversity in daily per capita (AME) Calorie intake levels, on average, across Samoa's 48 districts. Members of households in districts where average Calorie consumption is low (<1900 kcal per day, coloured green) have access to less than 50% of average energy requirements established in the ADER; while members of households in districts where average Calorie consumption is high (5 500 kcal or more per day, coloured red) have access to more than 150% of average energy requirements established in the ADER. Figure 1 indicates that 5 districts have a 'low' average Calorie intake: Aana Alofi I (district 9) and Anoamaa East (district 20) on Upolu, as well as Faaleleaga III (district

32), Faasaleleaga IV (district 33) and Falealupo (district 42) on Savaii. Figure 1 illustrates that 4 districts have a 'high' average Calorie intake: Aleipata Itupa I Lalo (district 19) and Vaa O Fonoti (district 22) on Upolu, as well as Gagaifomauga II (district 38) and Palauli West (district 45) on Savaii.

Figure 2: Map of per capita (AME) daily fat (g) intake by district

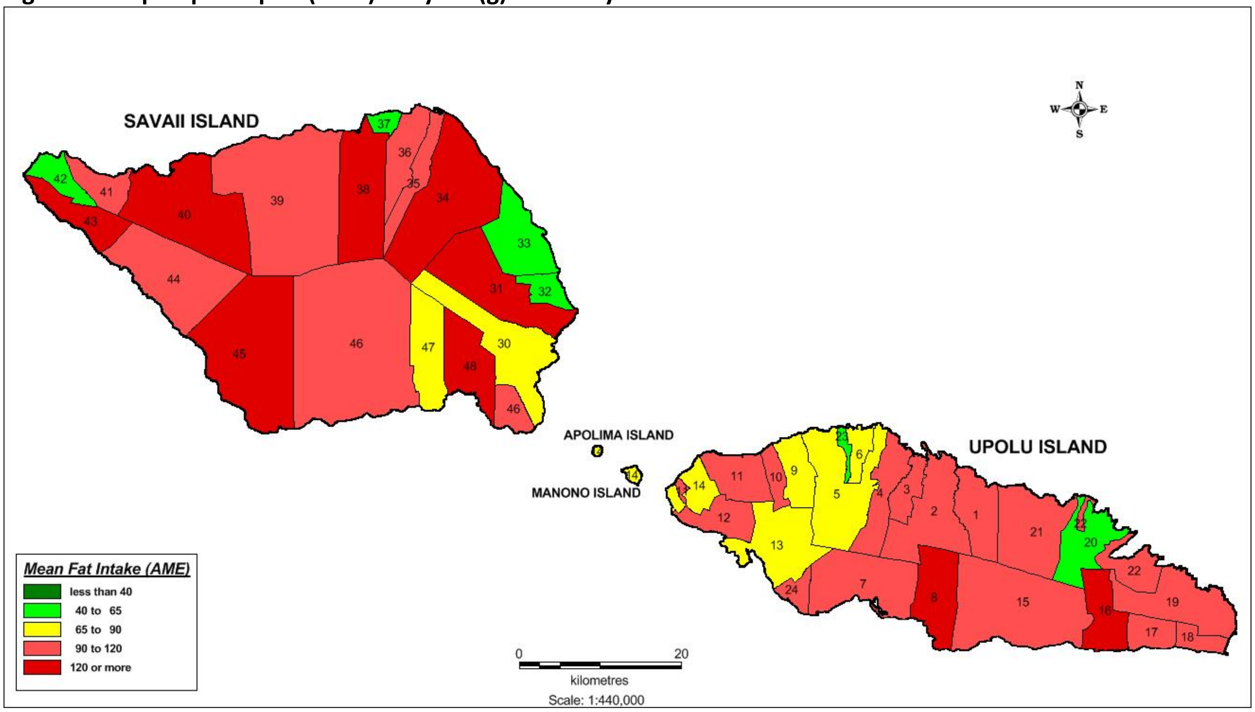

Figure 2 illustrates daily per capita (AME) fat intake levels, on average, across all Samoa's districts. Members of households in districts where average fat consumption is low (<40 grams per day, coloured green) are where fat contributes less than 10% of average energy requirements (ADER); while members of households in districts where average fat intake is high (>120 grams per day, coloured red) are where fat contributes more than 30% of average energy requirements (ADER). Figure 2 illustrates that 5 districts have a high average fat intake: Palauli East (district 48), Gagaemauga I (district 34), and Faasaleleaga II (district 31) on Savaii, as well as Lotofaga (district 16) and Siumu (district 8) on Upolu. No districts were found to have a 'low' intake of fat.

This map indicates that on average, households in all districts have access to sufficient fat intake. This map perhaps far more clearly illustrates that average fat intake is in the higher range, and is above or near to the upper limit in most districts.

Figure 3: Map of per capita (AME) daily sodium (mg) intake by district

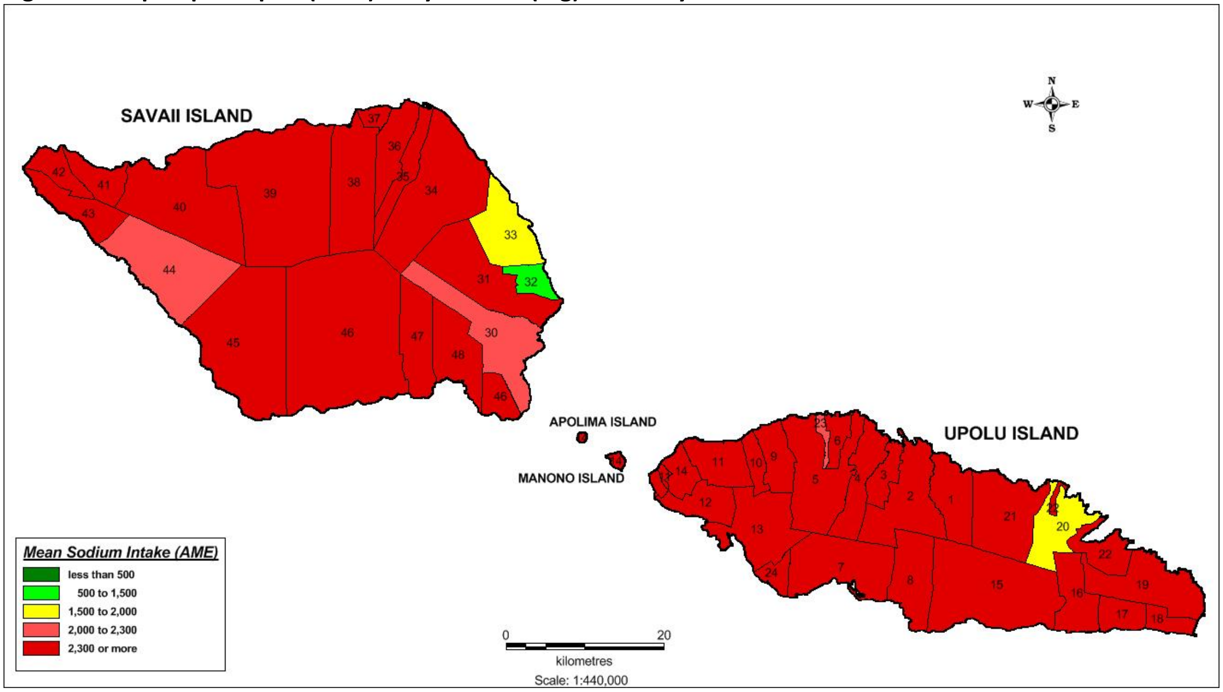

Figure 3 illustrates daily per capita (AME) sodium intake levels, on average, across all Samoa's districts. Members of households in districts where average sodium consumption is low (<500 milligrams per day, coloured green) are where sodium intake is less than the recommended daily minimum intake for adult males; while members of households in districts where sodium intake is high (>2 300 milligrams per day, coloured red) are where sodium consumption is higher than the recommended daily Upper Limit for an adult male. Figure 3 illustrates that there are no districts where sodium intake is low; and that in only 5 districts - Faasaleleaga I (district 30), Faasaleleaga II (district 31), Faaleleaga III (district 32) and Faasaleleaga IV (district 33) on Savaii, and Gagaemauga I (district 23) on Upolu – is average sodium intake below the recommended Upper Limit.

This map clearly indicates that on average, households in all districts have access to a level of sodium intake sufficient for proper cell functioning (500mg or more). The far more pressing national health issue is the number of districts where average sodium intake is above the upper limit.

Figure 4: Map of per capita (AME) daily protein (g) intake by district

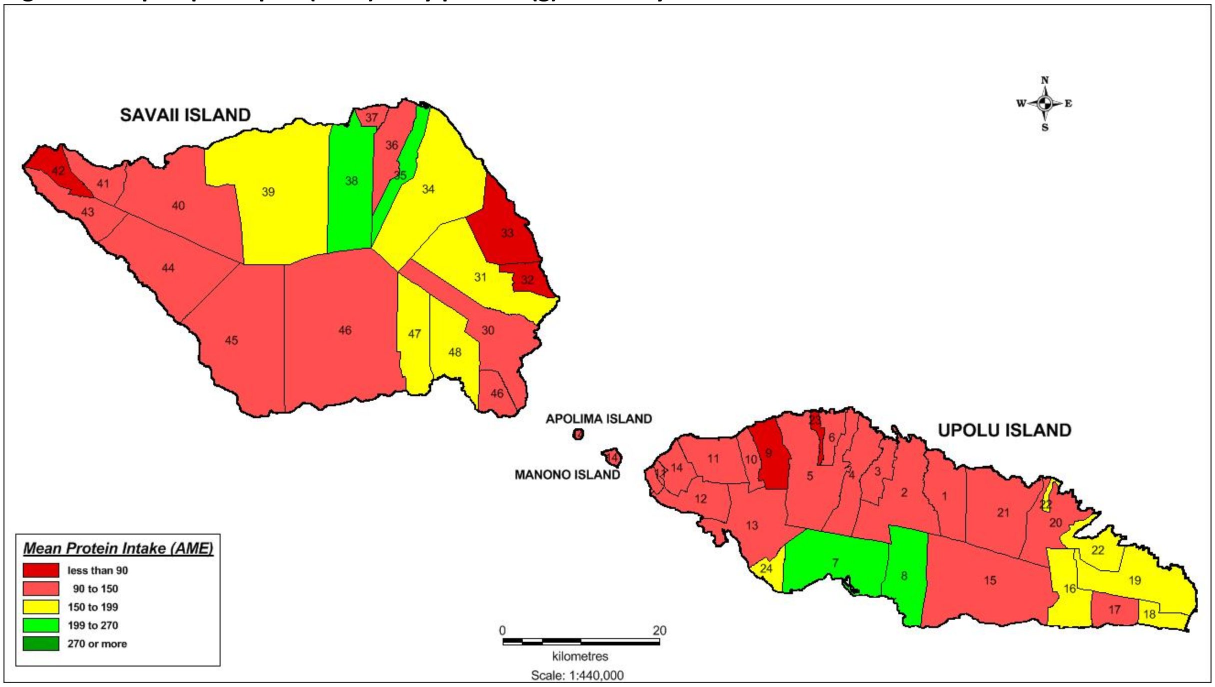

Figure 4 illustrates daily per capita (AME) protein intake levels, on average, across Samoa's 48 districts. Members of households in districts where average protein consumption is low (<90 grams per day, coloured red) are where protein contributes less than 10% of average energy requirements (ADER); while members of households in districts where average protein intake is high (>270 grams per day, coloured green) are where protein contributes more than 30% of average energy requirements (ADER). Figure 4 illustrates that 5 districts have a low protein intake: Faaleleaga III (district 32), Faasaleleaga IV (district 33) and Falealupo (district 42) on Savaii, as well as Aana Alofi I (district 9) and Gagaemauga I (district 23) on Upolu. No districts were found to have a high protein intake, based on international standards; however households in nearly all districts had access to a sufficient intake of protein.

Figure 5: Map of per capita (AME) daily iron (mg) intake by district

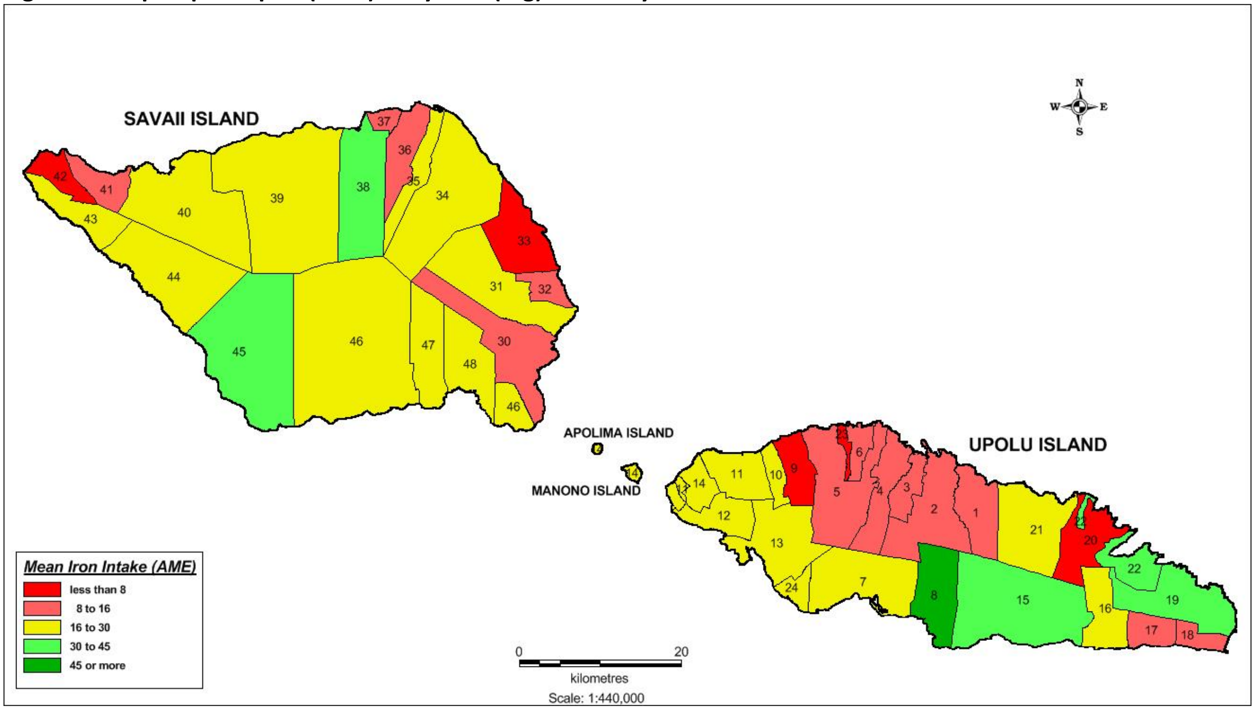

Figure 5 illustrates daily per capita (AME) iron intake levels, on average, across Samoa's 48 districts. Members of households in districts where average iron consumption is low (<8 milligrams per day, coloured red) are where iron intake is less than the recommended daily minimum intake for adult males; while members of households in districts where iron intake is high (>45 milligrams per day, coloured green) are where iron consumption is higher than the recommended daily safe Upper Limit for an adult male. Figure 5 illustrates that there are five districts where average iron intake is low: Aana Alofi I (district 9) Anoamaa East (district 20) and Gagaemauga (district 23) I on Upolu, and Faasaleleaga IV (district 33) and Falealupo (district 42) on Savaii. There are no districts where average iron intake is above the safe upper limit, with households in most districts having access to the required intake of iron.

Figure 6: Map of per capita (AME) daily vitamin A (ug) intake by district

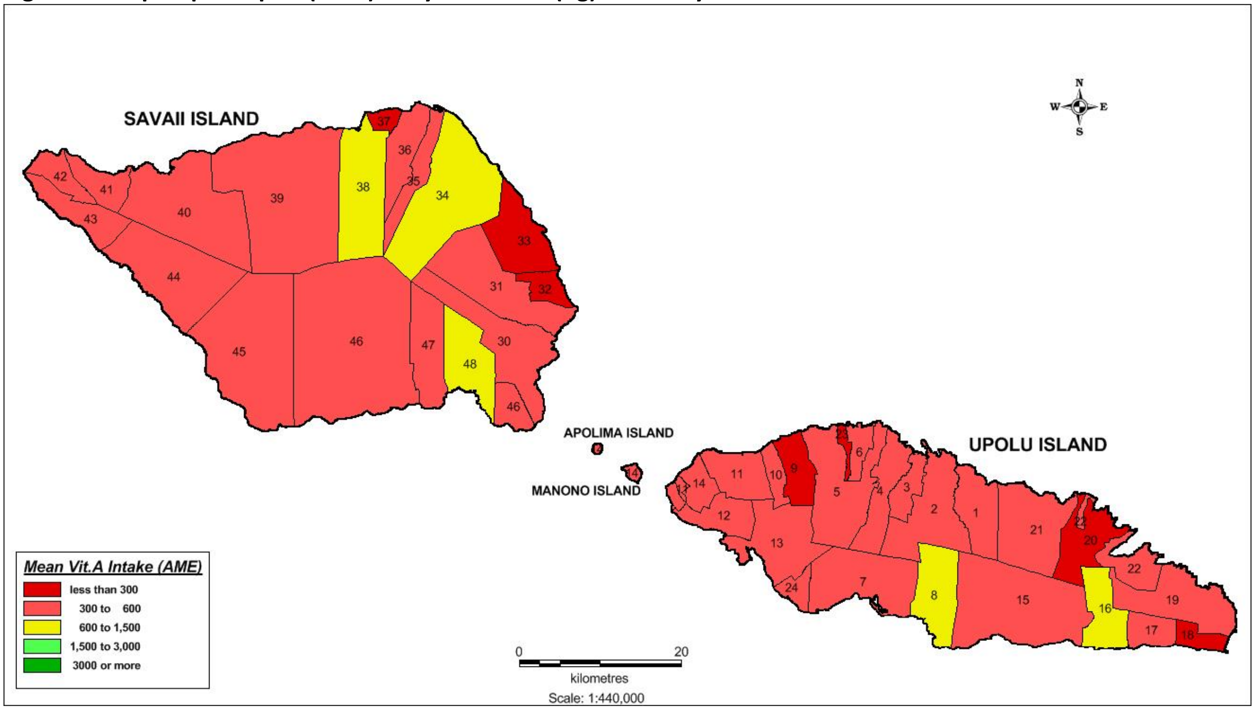

Figure 6 illustrates daily per capita (AME) vitamin A intake levels, on average, across Samoa's 48 districts. Given that the mean intake of vitamin A is below the level recommended for Samoan males, Figure 6 provides two colour bands below the recommended intake level in order to also identify those areas where intake is lowest. Members of households in districts where average vitamin A consumption is extremely low (<300 micrograms per day, coloured red) are where vitamin A intake is less than half the recommended daily minimum intake for adult males; while members of households in districts where average where vitamin A intake is low (<600 micrograms per day, coloured pink) are where vitamin A intake is below the recommended minimum, but more than half that rate. Members of households in districts where average where vitamin A intake is high (>3 000 milligrams per day, coloured green) are where vitamin A consumption is higher than the recommended daily safe Upper Limit for an adult male. Figure 6 helps us identify that members of households in 6 districts have a daily vitamin A intake which is very low; while members of households in only 5 districts have a vitamin A intake that is above the recommended minimum level (600micrograms), with the remaining 37 districts with an intake between 300 and 600mg per day. Members of households that have a vitamin A intake that is less than half of the recommended level for adult males are in the following districts: Aana Alofi I (district 9), Anoamaa East (district 20) and Gagaemauga I (district 23) on Upolu; and Faaleleaga III (district 32), Faasaleleaga IV (district 33) and Gagaifomauga I (district 37) on Savaii. Members of households that have a vitamin A intake that is above the recommended level for adult males are in the following districts: Palauli East (district 48), Gagaemauga I (district 34), and Gagaifomauga II (district 38) on Savaii; as well as Lotofaga (district 16) and Siumu (district 8) on Upolu.

This map clearly illustrates that low vitamin A consumption is an issue for a majority of Samoa's districts.

Figure 7: Map of share of households in district whose current food intake satisfies the recommended nutrient intake minimums and maximums

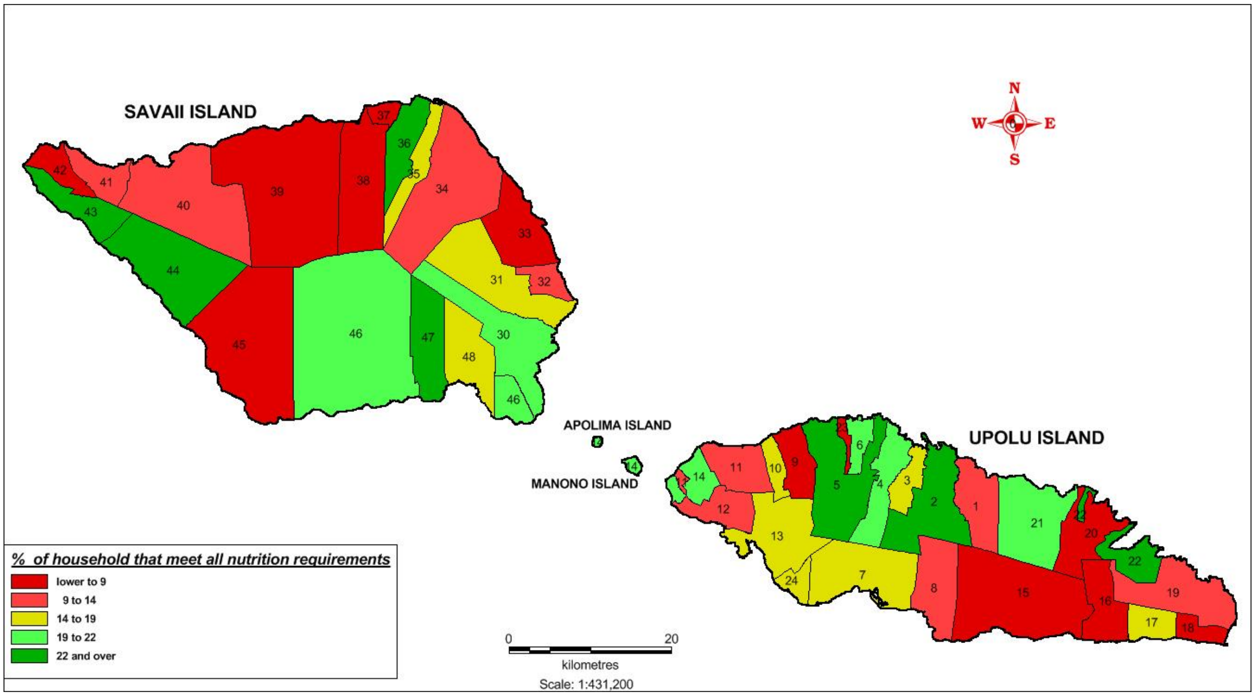

Figure 7 illustrates the share of households in each of Samoa's 48 districts, who have access to a diet which satisfies all the recommended nutrient intake minimums and maximums established here. On average, only 14% of households (per district) had access to a diet which satisfies the recommended nutrient intake levels. Figure 6 illustrates that 'satisfaction' of these dietary recommendations is low (coloured red) when 10% or less of households have access to the recommended intake levels; while satisfaction of these nutrient recommendations (coloured green) where 22% or more of households have access to the recommended intake levels. Figure 7 illustrates that there are eight districts where satisfaction is less than 10% (low): Aana Alofi I (district 9), Lotofaga (district 16), Aleipata Itupa I (district 18), Aleipata Itupa I (district 19) and Anoamaa East (district 20) on Upolu as well as Gagaifomauga I (district 37), Vaisigano West (district 41) and Palauli West (district 45) on Savaii. In 20 districts, the share of households satisfying all the set nutrient requirements is between 10% and 21%. In 8 districts, between 22 and 29% of households have a diet which satisfies all the recommended nutrient intake requirements. No districts have more than 30% of households satisfying the recommended minimums.

3.3 Differences in nutrient intake levels by household size

Table 10: Difference in per capita (AME) access to micro and macronutrients, by number of household members

	Calories (kcal)	Fat (g)	Sodium (mg)	Protein (g)	Iron (mg)	Vit. A (ug)	Observations
Overall	3 509	96	2 903	127	18	433	2 286
4 or less	4 378	124	3 708	158	25	604	593
5-8	3 498	100	2 945	129	17	434	1 072
9 or more	2 788	68	2 152	96	14	287	621

Table 10 indicates that access to calories declines as the number of members of the household increases. Those households with 4 or less members access far more calories than the national average, whilst households supporting 9 or more members access far less. This result is consistent with the logic that an increase in the number of members divides the household food supply, given that the number of 'breadwinners' (income or food producers) supporting the household is limited (usually 2 or less).

The same trend as for calories is repeated in the other nutrient intake categories: members of households with a greater number of members (5+) have access to lower intake levels than members of households with fewer members (4 or less).

3.4 Differences in nutrient intake levels by household head gender

Table 11: Difference in per capita (AME) access to micro and macronutrients, by household head gender

	Calories (kcal)	Fat (g)	Sodium (mg)	Protein (g)	Iron (mg)	Vit. A (ug)	Observations
Overall	3 509	96	2 903	127	18	433	2 286
Male	3 553	96	2 917	129	19	433	1 836
Female	3 335	97	2 848	118	16	433	450

Table 11 indicates that members of female headed households have access to lower nutrient intakes for calories, sodium, protein, and iron. Members of households headed by females have access to the same intake of Vitamin A, and a marginally higher intake of fat. The reason for this result is perhaps a consequence of members of female headed households living in greater hardship than male headed households. However, Table 11 indicates members of female headed households only fail to access the recommended daily intake of Vitamin A and calories, as do members of male headed households.

3.5 Differences in nutrient intake levels by household head age

Table 12: Difference in per capita (AME) access to micro and macronutrients, by household head age

	Calories (kcal)	Fat (g)	Sodium (mg)	Protein (g)	Iron (mg)	Vit. A (ug)	Observations
Overall	3 509	96	2 903	127	18	433	2 286
Age below 30	3 793	116	3 498	157	18	638	79
Age 30 +	3 724	103	3 313	144	17	489	316
Age 40 +	3 474	93	2 972	124	17	413	553
Age 50 +	3 614	99	2 912	126	19	444	620
Age 60 +	3 339	96	2 704	122	18	412	393
Age 70 +	3 346	89	2 569	117	18	382	325

Table 12 indicates that members of households headed by older individuals (60+) generally access lower intake levels of calories, fat protein, sodium and vitamin A, than do members of households headed by younger individuals. This result is consistent with the notion that households headed by older individuals, have a lower income or food producing capacity given the reduced efficiency of farm labour (or rate of engagement in formal employment) among households where one 'breadwinner' is aged. However, iron intake among members of older households, however, is higher to or equal to households with younger household heads – though the difference being just one or two milligrams, and with all households accessing sufficient iron. This outcome might be the result of differences in food choices between households headed by older and younger individuals, such as differences in the rate of consumption of taro (high in iron and a major food item in the household basket). The food items most important to household iron consumption will be explored in section 5.

3.6 Differences in nutrient intake levels by household head education level

Table 13: Difference in per capita (AME) access to micro and macronutrients, by household head education level

	Calories (kcal)	Fat (g)	Sodium (mg)	Protein (g)	Iron (mg)	Vit. A (ug)	Observations
Overall	3 509	96	2 903	127	18	433	2 286
Primary or less	3 733	97	3 133	133	19	455	308
Junior Secondary	3 650	96	2 918	127	19	408	1 228
Senior Secondary	3 430	93	3 043	124	17	423	252
Tertiary	2 973	100	2 627	123	14	501	498

Table 13 indicates that households where the head has a higher level of educational attainment have a reduced intake of most macro and micronutrients: calories, sodium, protein and iron. This result is

perhaps explained by a lower rate of demand for food intake resulting from an increased level of participation in off-farm employment and other 'non-manual' income generating activities, by household heads with higher levels of educational attainment. The access to dietary intake containing higher levels of fat among households headed by individuals who have obtained tertiary education is perhaps a result of changing food preferences (i.e. for fattier meat products) among households with higher levels of disposable income. The higher levels of Vitamin A intake among households where the head is tertiary educated may similarly be the result of changing food preferences resulting from higher levels of disposable income, enabling these households to purchase fruit, vegetable and dairy products containing higher Vitamin A levels. The food items most important to vitamin A intake in Samoa are further explored in section 5.

3.7 Differences in nutrient intake levels by tercile of household income

Table 14: Difference in per capita (AME) access to micro and macronutrients, by tercile of household income

	Calories (kcal)	Fat (g)	Sodium (mg)	Protein (g)	Iron (mg)	Vit. A (ug)	Observations
Overall	3 509	96	2 903	127	18	433	2 286
1st tercile (0-33%)	3 517	87	2 724	113	19	345	730
2nd tercile (34-66%)	3 665	100	3 033	128	19	449	740
3rd tercile (67-100%)	3 344	102	2 953	139	16	506	816

Table 14 indicates that households whose total income places them within the lowest tercile levels of total income (similar to the bottom three deciles) access lower levels of fat, protein, Vitamin A and sodium than households in the two higher income terciles. However, Table 14 also indicates that households in the lowest income tercile consume more calories (on average) than households in the two terciles above. This finding may be the result of higher levels of participation in physically demanding activities, such as farming, among households in the lowest tercile – leading them to have a higher demand for calories than households in higher income terciles, where participation in off-farm (and generally less physical demanding) employment is greater. Households in the lowest income tercile also have access to a (slightly) greater intake of iron than households in the highest income tercile, perhaps as a result of changing food preferences among households at higher income terciles leading to decreased consumption of root crops containing high levels or iron, such as taro, in favour food substitute products. The higher share of fat (27%) and protein (17%) in total energy consumption among households at the highest income tercile, compared to the contribution of fat (22%) and protein (12%) to energy consumption among households in the lowest income tercile, indicates a shift towards fat and protein at higher levels of income. Similarly, the higher level of access Vitamin A intake among households in the top income tercile is perhaps also a consequence of the changing composition of diet (as for households headed by tertiary educated individuals) among wealthier households towards dairy products, and fruits and vegetables.

3.8 Differences in nutrient intake levels by share of household income spent on contributions to church and other households

Table 15: Difference in per capita (AME) access to micro and macronutrients, by share of household income of household income

	Calories (kcal)	Fat (g)	Sodium (mg)	Protein (g)	Iron (mg)	Vit. A (ug)	Observations
Overall	3 509	96	2 903	127	18	433	2 286
Below mean*	3 665	98	3 026	130	19	426	1 382
Above mean*	3 247	94	2 696	121	17	446	904

* Mean of household income expended on gifts (goods and cash) to church and other households is 16.8%

Table 15 explores the potential for higher levels of expenditure on gifts to impact upon dietary intake levels. It compares the dietary intake values of households whose expenditure on gifts - including transfers to other households, including in support of funerals, weddings and other ceremonies; as well as contributions to churches –is higher than the mean, as a share of total household income (16.8%) with households whose share of income spent on these 'gifts' is lower than the mean. The results presented in Table 15 indicate that households whose income share spent on gifts is higher than 16.8%, have access to a lower intake of calories, fat, sodium, protein and iron (though higher Vitamin A). The share of calories from fat is lower (24%) among these households, than households who spent less (as a share of income) on gifts (26%), though the share of protein in calories remains the same (14%). The results in Table 15 perhaps indicate that, perhaps due to social obligations or expectations, some participate in transfers of income to other households and to Churches to the extent that we begin to see a decline in dietary quality. However, the increase in access to Vitamin A among households investing a greater share of their income in gifts would seem to be in contradiction to this trend. The impact of gifts on dietary intake is explored in greater detail, using OLS regression analysis, in the next section.

4. Correlation between indicators of household poverty and diet

In this chapter, we use OLS regression analysis to identify the marginal effects of household variables commonly used to identify poverty and hardship in PICs, on nutrient intake levels and access to a diet that satisfies all the recommended intake levels for Calories, fat, sodium, protein, iron and vitamin A, established in this study (Table 8).

The household variables (described in Chapter 3) are: that the gender head of household is female; the age of the household head (years); that the household head has not obtained post-primary education; the number of household members; a total household income level in the bottom 33% (tercile) compared to the top tercile; a total household income level in the middle 33% (tercile) compared to the top tercile; whether the household spends more than the mean share of income[64] (16.8%) on gifts of goods and cash to church and to other households; and how the intake levels of households in the regions of Savaii, NW Upolu (per-urban) or 'Rest of Upolu' compares with household is an urban region (Apia).

Table 16 displays the results for7 separate OLS regressions. The 7 dependent variables are: (1) that household food expenditure provides a diet that is above the RDI protein, Vitamin A and iron, below the UL for fat and sodium, and between 50% and 150% of the calories in the ADER; (2) calorie intake; (3) protein intake; (4) fat intake; (5) sodium intake; (6) iron intake; (7) vitamin A intake.

Table 16 reports marginal effects based on coefficient estimates. This enables the interpretation of these statistics directly as a percentage change (at the mean of the independent variables) in the likelihood of households described by the variable satisfying the nutrition thresholds of the dependent variable established in the first regression (meets all micro and macronutrient RDI and ULs) as well as the actual change in household daily per capita (AME) intake of Calories (kcal), protein (g), fat (g), sodium (mg), iron (mg), and Vitamin A (ug). The standard errors are reported in brackets below the marginal effects of the independent variable, for each regression. Significance is denoted by the symbols **, * and +, where the significance level for **= p<0.01, * =p<0.05, += p<0.1. Standard errors and shown in parentheses below the marginal effects.

The statistically significant effects are subsequently presented in graphical form (Figures 1-7) and these results are interpreted and discussed.

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[64] We estimated the share of income on gifts by adding-up expenditure on N.E.C., expenditure on Faalavelave and cash donations (sections 2.8.1 and 2.9.1of HIES questionnaire) and then dividing it by total income. Our estimate differ from the expenditure share on gifts as reported in the SBS analysis since: (i) we used a different classification to construct the component of gift expenditure; (ii) we divided expenditure on gifts over income rather than expenditure.

Table 16: OLS regression analysis of marginal effects of household factors on nutrient intake

VARIABLES	(1) Meets all RDI and UL[1]	(2) Calorie (kcal) intake	(4) Protein intake (g)	(5) Fat intake (g)	(6) Sodium intake (mg)	(7) Iron Intake (mg)	(8) Vit. A Intake (ug)
Head of household is female	-0.05**	74.60	0.72	7.85	197.66	-1.02	37.21
	(0.019)	(184.367)	(6.866)	(5.718)	(189.047)	(1.239)	(43.996)
Household head age (years)	0.00	-14.91*	-0.85**	-0.48**	-22.46**	-0.01	-3.24*
	(0.001)	(6.175)	(0.253)	(0.182)	(6.418)	(0.044)	(1.446)
Household head education	0.03*	-1131.99+	-3.71	0.76	-160.76+	-0.61	7.52
	(0.012)	(70.669)	(4.525)	(2.338)	(84.661)	(0.468)	(14.984)
Household in bottom tercile of total income	-0.12**	-213.48	-38.05**	-17.27**	-368.19*	0.35	-173.01**
	(0.023)	(177.221)	(10.681)	(4.863)	(177.044)	(1.270)	(33.517)
Household in middle tercile of total income	-0.05*	-10.57	-18.39*	-3.70	29.16	0.37	-62.39
	(0.023)	(158.153)	(8.937)	(5.231)	(182.888)	(1.039)	(39.500)
Share of hh income expended on gifts is above the mean	0.00	-303.32+	-11.05+	-4.79	-304.25**	-1.26	-4.54
	(0.016)	(176.087)	(6.274)	(4.144)	(141.835)	(1.194)	(28.079)
Household on Savaii	0.01	1092.03**	18.77	11.45	-302.89	8.48**	-50.45
	(0.033)	(363.820)	(14.780)	(13.011)	(228.027)	(2.420)	(57.897)
Household in NW Upolu region	0.01	106.51	-7.46	-11.06*	-223.21	2.38+	-56.94
	(0.034)	(174.010)	(6.515)	(5.501)	(163.219)	(2.420)	(43.573)
Household in Rest of Upolu region	-0.04	1588.92**	32.66*	2.64	-123.34	14.68**	-28.77
	(0.026)	(290.868)	(14.691)	(6.881)	(234.885)	(2.397)	(46.211)
Observations	2286	2286	2286	2286	2286	2286	2286
R squared	0.035	0.167	0.111	0.110	0.085	0.179	0.086

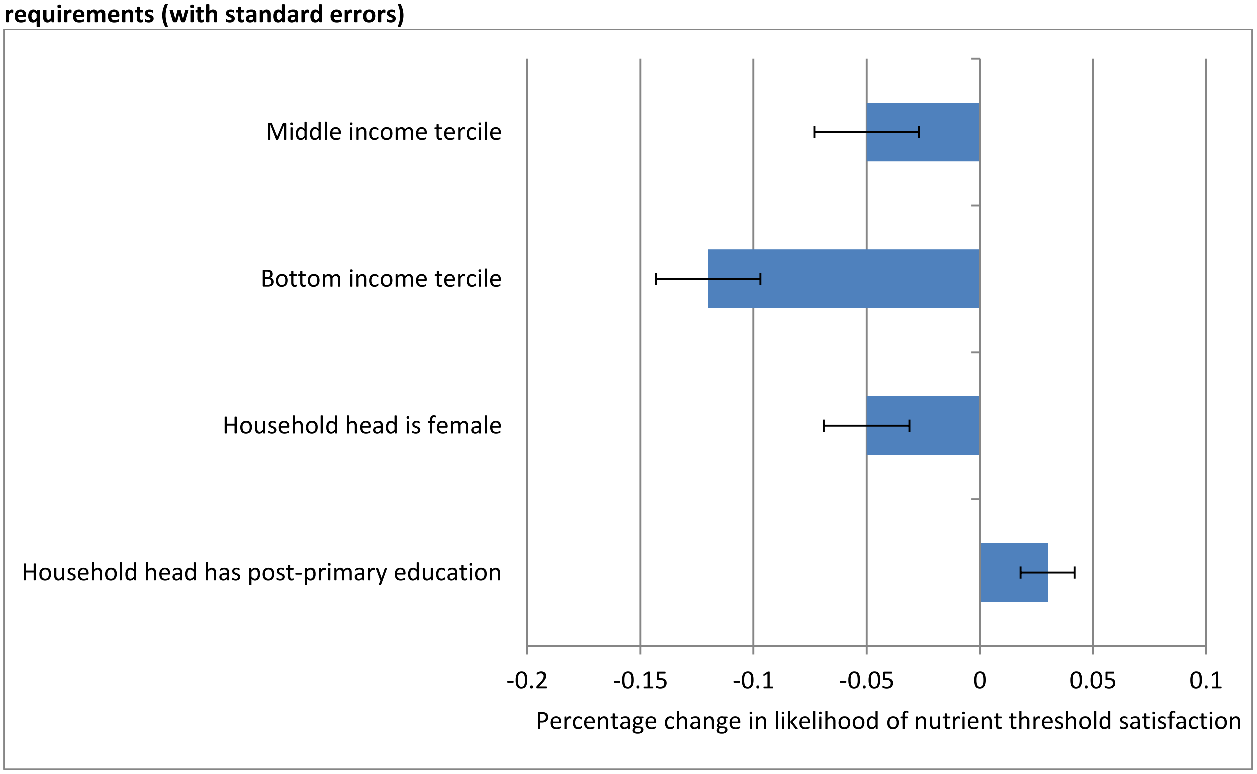
Significance is denoted by the symbols **, * and +, where the significance level for **= p<0.01, * =p<0.05, += p<0.1. Standard errors and shown in parentheses

[1] Households meets all RDI and UL thresholds when AME consumption: kcal/day >50% but <150% ADER (x=>1835 and <5504); fat g/day >82 and <122; protein g/day >92; sodium mg/day >1610 and <2300; iron mg/day >8; vitamin A ug/day >600

4.1 Household member satisfaction of all macro and micronutrient intake thresholds

Table 16 indicates that four factors (independent variables) were found to have a significant marginal effect on household members having access to a diet which satisfies all the macro and micronutrient intake thresholds (ADER, RDI and UL) associated with an adequate diet in Samoa (the dependent variable). Figure 8 illustrates that members of households headed by a female, and those in the bottom and middle income terciles (0-33%; and 34-66%), are less likely to access a diet which meets the recommended nutrient intake levels; while members of households headed by someone who has obtained post-primary education, are more likely to access a diet satisfying the recommended nutrient intake levels. Figure 8 shows that households with a female household head are 5% less likely to satisfy these nutrition thresholds; that households in the bottom income tercile are 12% less likely than households in the top income tercile to access a diet satisfying all the nutrition thresholds; and that households in the middle income tercile are 5% less likely than households in the top income tercile, to access a diet satisfying all the nutrition thresholds. Figure 8 also shows that members of households headed by an individual who has obtained a post-primary level of education (or more than 8 years schooling) are 3% more likely to have access to a diet satisfying the recommended nutrient intake thresholds established in this study.

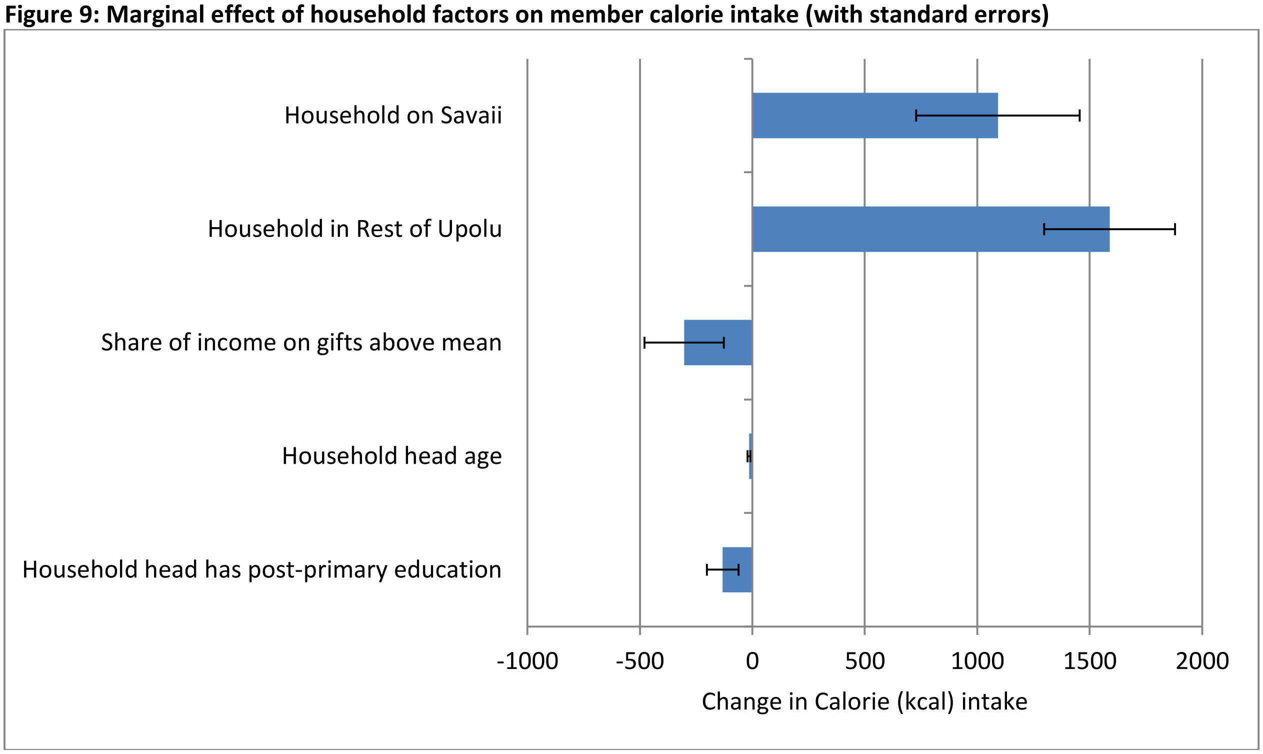
Figure 8: Marginal effect of household factors on member satisfaction of all micro and macronutrient intake requirements (with standard errors)



4.2 Household member calorie intake

Table 16 indicates that five factors have a significant marginal effect on household member calorie intake. An increase in the age of the household head, an increase in the level of household head education to the post-primary level, and an increase in household spending (as a share of income) on gifts above the mean share, were found to reduce household member Calorie intake; while members of households in two 'rural' regions – Savaii and 'Rest of Upolu' – have access to a greater calorie intake than members of households in Apia. The results in Figure 9 indicate that an increase in the age of the household head by one year reduces household member Calorie intake by approximately 15 Calories - or 150 Calories for each decade increase in the age of the household head. Members of households where the head has obtained a post-primary level of education, access 130 Calories fewer than households where the head does not have this level of education. Members of households where the share of income spent on gifts is above the mean, access 303 Calories less than households whose share of income expended on gifts is less than the mean. Figure 9 also illustrates that members of households located in the 'Rest of Upolu' region have access some 1588 Calories more per day, on average, than households in Apia; while members of households on Savaii have access to 1092 Calories per day more.

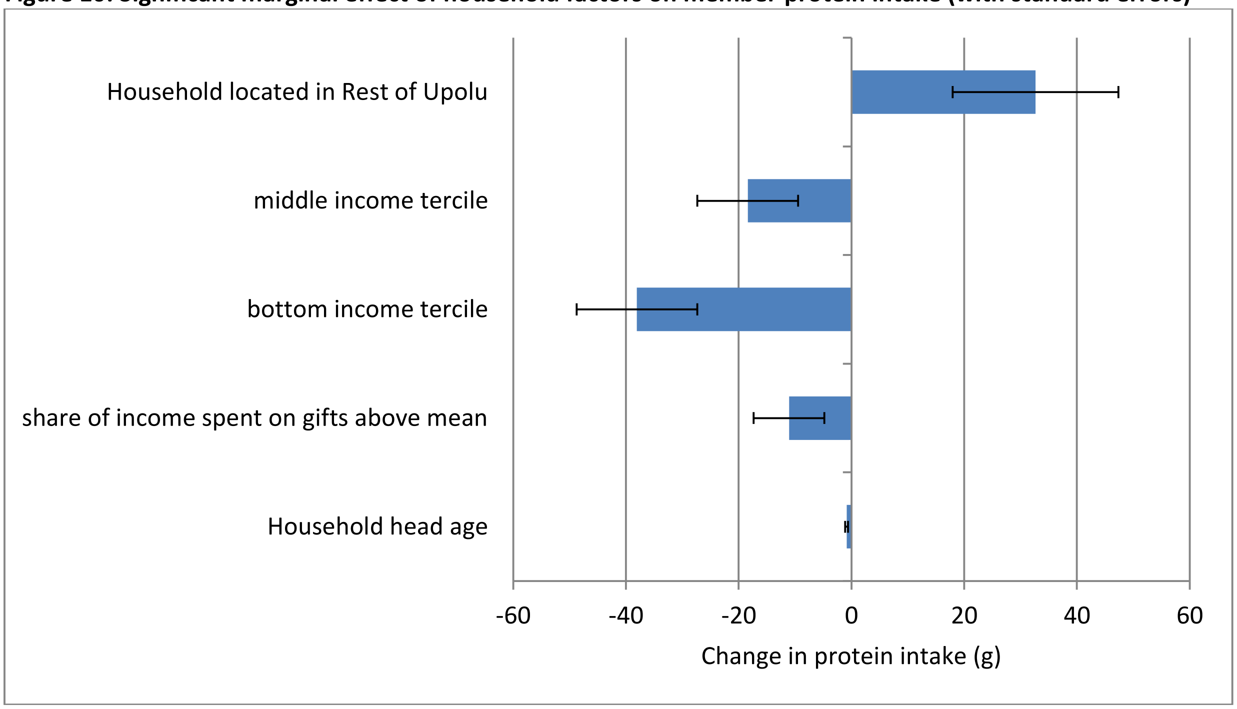
Figure 9: Marginal effect of household factors on member calorie intake (with standard errors)



4.3 Household member protein intake

Table 16 indicates that five factors have a significant marginal effect on household member access to protein. An increase in household spending (as a share of income) on gifts above the mean share, an increase in the age of the household head by one year, and membership of a household in the bottom or middle income terciles (0-33%; and 34-66%) all reduce household member intake of protein; while households located in the 'Rest of Upolu' region have access to a higher protein intake than households in the Apia region. Figure 10 shows that an increase in the age of the household head by one year decreases daily intake of protein by 0.85grams per member. Members of households whose share of income spent on gifts is above the mean have access to 11 grams of protein less than members of households with a share of income spent on gifts that is below the mean. Members of households in the bottom income tercile have access to 38 grams less of protein than members of households in the top income tercile; while members in the middle income tercile have access to 18 grams less of protein per day. Figure 10 also shows that households located in the 'Rest of Upolu' region have access to 32 grams more of protein a day than households located in the Apia region.

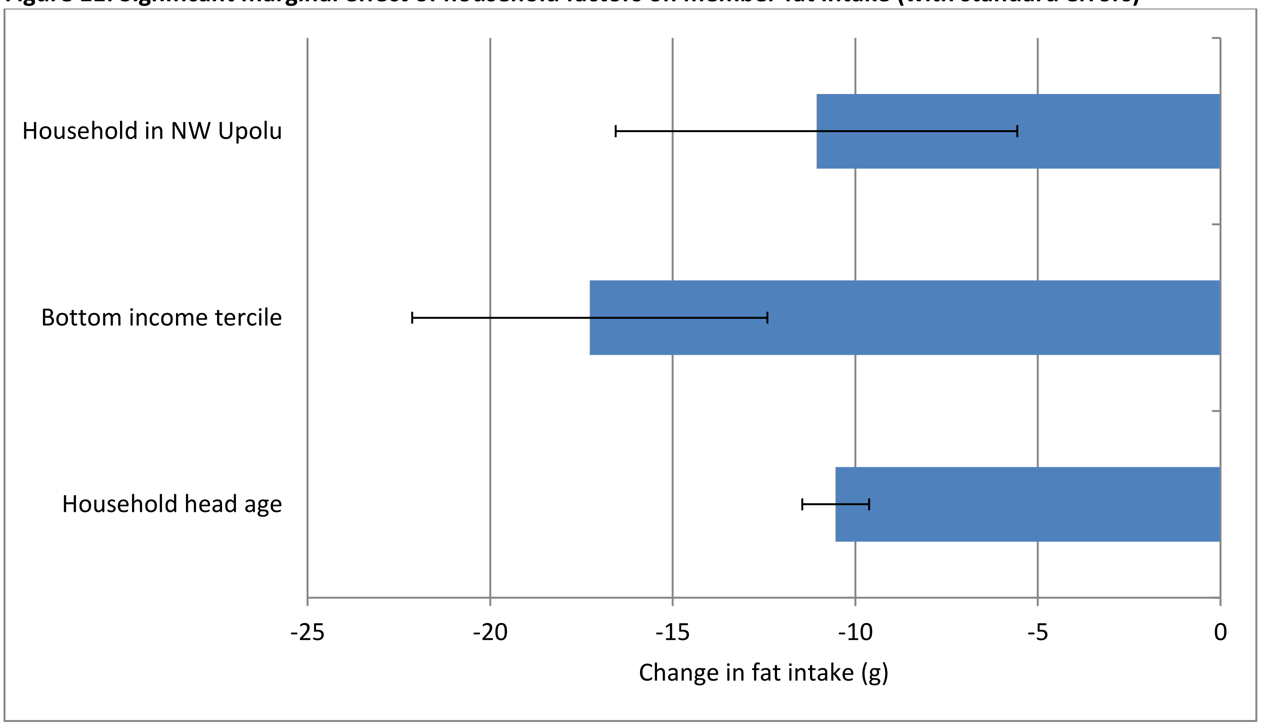
Figure 10: Significant marginal effect of household factors on member protein intake (with standard errors)



4.4 Household member fat intake

Table 16 indicates that three factors have a significant marginal effect on household member fat intake. An increase in the age of the household head by one year, membership of a household in the bottom tercile of income and membership of a household located in the NW Upolu, all reduce household member access to fat. Figure 11 illustrates that an increase in the age of the household head by one year, decreases the average daily intake of fat available to members of that household by 10 grams. Members of households in the bottom income tercile have access to 17 grams of fat less than households in the top income tercile. Finally Figure 4 indicates that households in the 'NW Upolu' region have access to 11 grams of fat less than households in the Apia region.

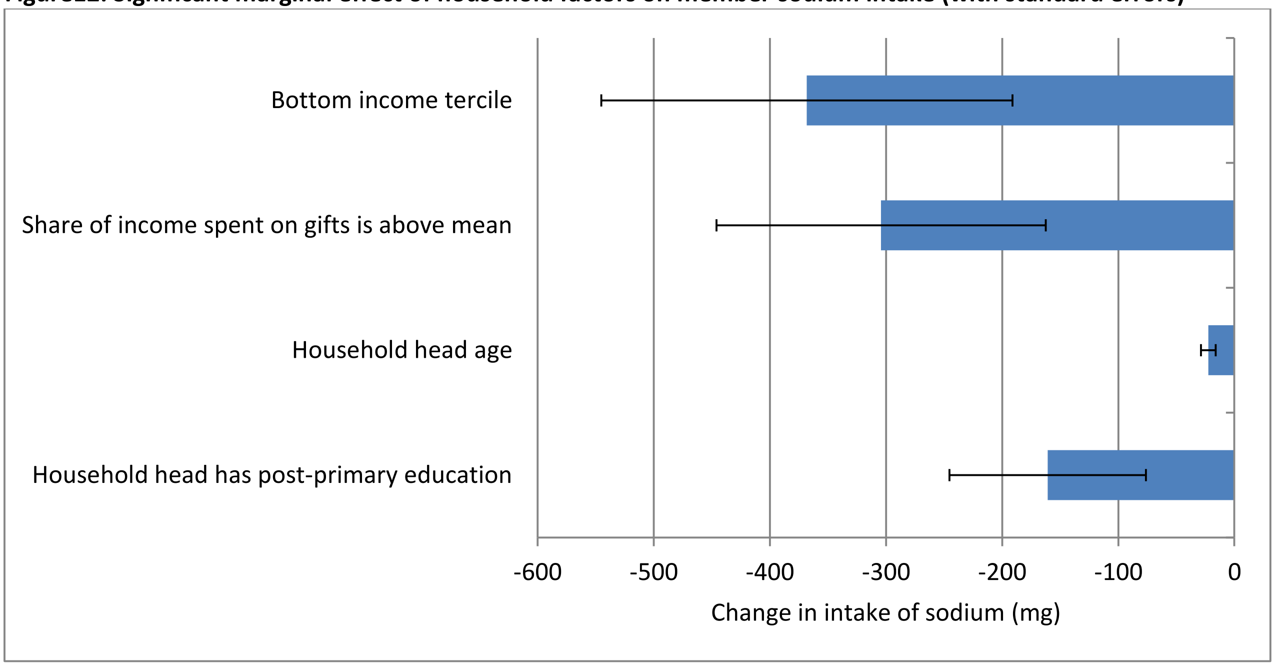
Figure 11: Significant marginal effect of household factors on member fat intake (with standard errors)



4.5 Household member sodium intake

Table 16 indicates that four factors have a significant marginal effect on household member sodium intake. An increase in the household heads education to a post-primary to obtained post-primary level, an increase in the age of the household head by one year, membership of a household where the share of income spent on gifts is higher than the mean, and membership of a household located in the bottom income tercile has negative marginal effect on sodium intake. Figure 12 illustrates that a member of a household where the head has obtained a post-primary level of education access 160 millgrams of sodium fewer than households where the head does not have this level of education. An increase in the age of the household head by one year decreases household member sodium intake by 22mg. Members of households where the share of income spent on gifts is higher than the mean, access 304mg less of sodium than households who spend a lower share of income on gifts. Households in the bottom income tercile access to 368 mg of sodium per day less than members in the top income tercile.

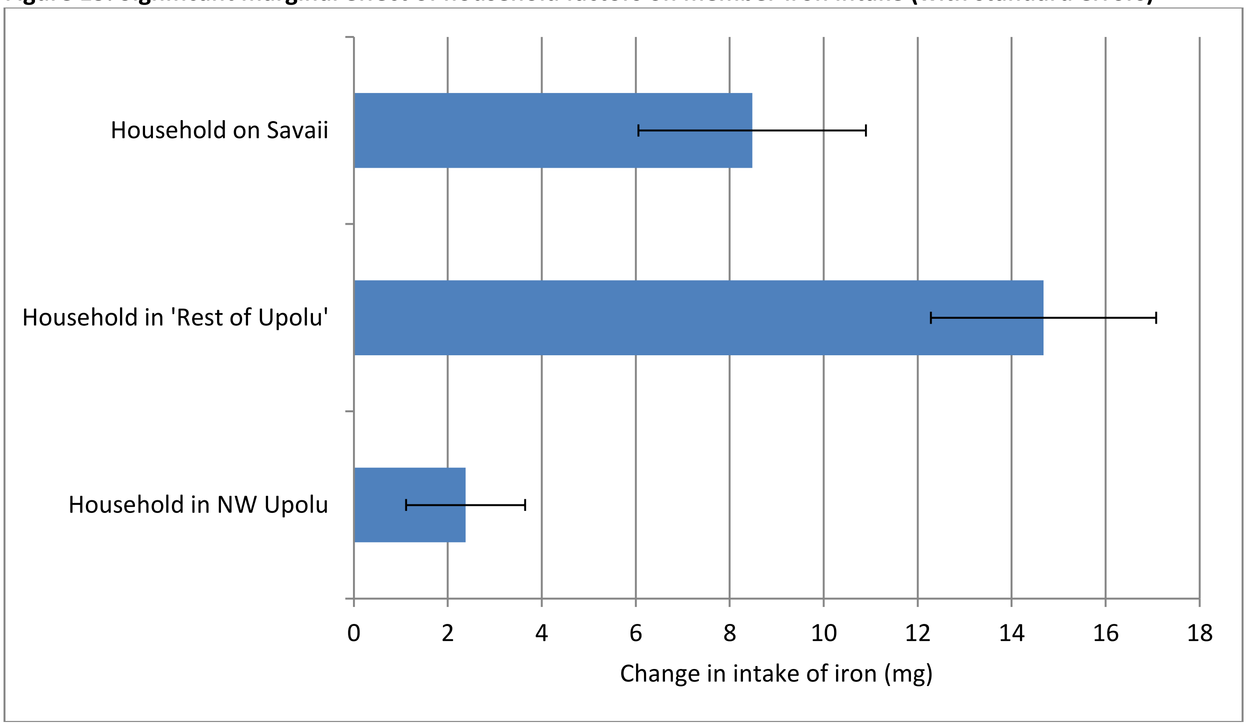
Figure12: Significant marginal effect of household factors on member sodium intake (with standard errors)



4.6 Household member iron intake

Table 16 indicates that three factors have a significant marginal effect on household member intake of iron. Members of households in any of the three 'rural' Regions of Savaii, NW Upolu and Rest of Upolu have access to a higher iron intake level than members of households in Apia. Figure 13 shows that members of households on Savaii are found to have access to an additional 8 grams of iron per day than members of households in Apia; whilst members of households in the 'Rest of Upolu' region have access to an additional 14 grams of iron, and members of households in NW Upolu an additional 2 grams of iron, when compared to members of households in the Apia region. This is likely to reflect a higher intake of taro, with its high iron content, in households more distant from the urban areas.

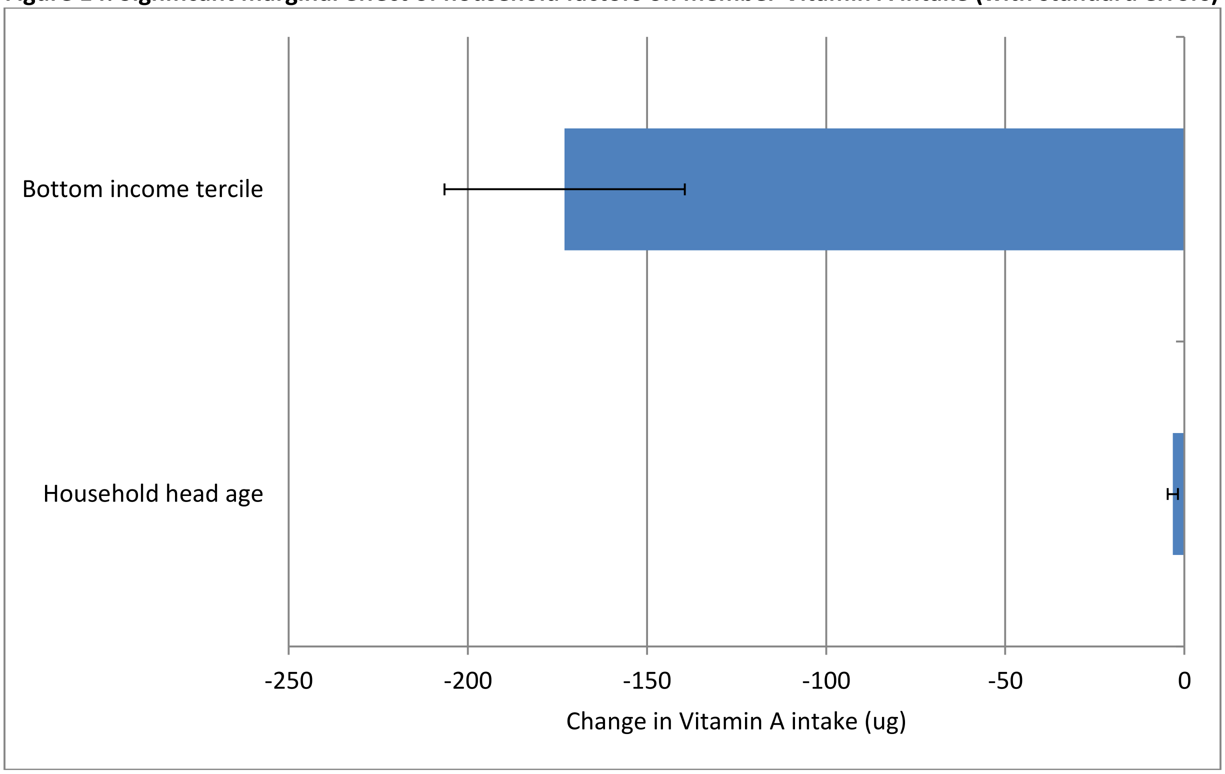
Figure 13: Significant marginal effect of household factors on member iron intake (with standard errors)



4.7 Household member Vitamin A intake

Table 16 indicates that two factors have a significant marginal effect on household member vitamin A intake. Figure 14 illustrates that there is a negative marginal effect on vitamin A intake associated with an increase in the age of the household head and membership of a household in the bottom income tercile. An increase in the age of the household head by one year was found to decrease total vitamin A intake by 3 micrograms (ug), while members of households in the bottom income tercile had access to 173 ug less vitamin A per day than members of households in the top income tercile.

Figure 14: Significant marginal effect of household factors on member Vitamin A intake (with standard errors)



4.8 Discussion of results

The results presented in the preceding Table (16) and Figures (8-14) indicate that a number of significant factors affecting nutrient intake in Samoa.

The gender of the household head was found to have a significant marginal effect on the capacity of members of the household to access to a diet satisfying all the nutrient intake thresholds, with members of female headed households found to have a slightly lower chance of accessing an adequate diet (or simultaneously satisfying all the nutrient intake thresholds). The level of income was shown as also have a significant effect on the capacity of households to access a diet satisfying all the nutrient thresholds, with households in lower (both bottom and middle) income terciles less likely to access the recommended intake levels, when compared to households in the top income tercile. Household head education was found to have a significant impact on household member access to a nutritious diet, with members of households where the head had completed primary education – or the first 8 years of schooling – and gone on to further study, being more likely to access a diet satisfying all the recommended nutrient intake levels.

An increase in the education level of the household head, beyond primary education was found to also have a significant marginal effect on reducing Calorie and sodium intake levels. An increase in the education level of the household head to post-primary was found to reduce Calorie intake by 132 – or just 3% when compared to the mean. The reduction in calorie intake is perhaps indicative of the changed employment profile (movement from farming to office work) and lower levels of physical activity associated with households where the head has obtained a higher level of education. The reduction in sodium intake by 160mg – or 5% when compared to the mean - among households where the head has obtained a higher education perhaps indicates that educated household heads are more aware of the impact of high sodium consumption on diet and health, and are selecting food items with a lower sodium content, or adding less salt at table or when preparing food.

An increase in the age of the household head was found to have a relatively small impact on the volume of household member nutrient intake for Calories, protein, fat, sodium and vitamin A. An increase of one year in the age of the household head decreased Calorie intake by 15 or 150 for each decade increase in the age of the household head –a 4% decrease in Calorie intake when compared to the mean (3509). An increase of one year in the age of the household head decreased protein intake by 0.85g or 8.5 grams for every decade increase in the age of the household head - a 6% decrease when compared to the mean (127g). An increase of one year in the age of the household head decreased fat intake by 0.48g or 4.8 grams for every decade increase in the age of the household head - a 5% decrease when compared to the mean (96g). An increase of one year in the age of the household decreased Vitamin A intake by 3.24 micrograms or 32.4 micrograms for every decade increase in the age of the household head - a 7% decrease when compared to the mean (433ug). An increase of one year in the age of the household head decreased sodium intake by 22.46 grams or 224.6 grams for every decade increase in the age of the household head – a 7% decrease when compared to the mean (2903mg). These results are perhaps an indication of the impact of the lower productivity of waged/farm labour committed by

aged household heads, on household income, and therefore an involuntary reduction in food expenditure and therefore nutrient intake. Alternatively these results could be interpreted as reflecting a voluntary preference for a lower rate of food intake among older household heads, perhaps reflecting a greater appreciation of the positive impact of moderation of food consumption.

A low level (bottom tercile) of income was a significant factor in five regressions, with households in the bottom income tercile accessing a lower intake of fat, protein, sodium and vitamin A than households in the top income tercile. Households in the middle income tercile also accessed a lower intake of protein than households in the top income tercile. The reduced rate of protein intake among lower income groups is expected, given that more expensive meat products high in protein are less likely to feature as prominently the food baskets of members of these households as among higher income households. However the extent of the decreases in protein consumption among households in the bottom income tercile when compared to households in the top tercile – 38grams, or 30% of mean protein consumption – and among households in the middle income tercile with those in the trop tercile -18 grams, or 14.4% of mean protein consumption – are considerable. The lower rate of intake of sodium (12.6% as a share of the mean) and fat (17% as a share of the mean) when compared to the top income tercile is a positive outcome, given the high average intake levels reported earlier in this study. One can ascertain from this result, then, that high income does have a large marginal effect on sodium and fat intake, and that households in these income brackets should be targeted by policies aimed at reducing sodium and fat intake levels in the Samoan population. The reduced intake of vitamin A among low income households - 173ug or 40% of mean consumption – when compared to higher income households is a cause for concern, given the low average rate of access to vitamin A in the Samoan population revealed by this study. As a result, interventions to improve vitamin A intake in the general population could be augmented by a particular focus on low income households.

Members of households in the 'rural' regions of Savaii and 'Rest of Upolu' were found to have higher intake levels of calories and iron, than households in Apia. The higher calorie intake of members of households in these areas would be proportionate with the increase energy intake required as a result of higher levels of participation in farming and 'manual labour.' The increased iron intake is perhaps a consequence of both consuming a greater number of calories, as well as these rural households consuming a diet containing more root crops (such as own produced taro) high in iron. The increased intake of protein in the 'Rest of Upolu' is proportionate with the increased intake of calories, indicating that members of households in this region are not shifting towards a diet higher in protein, but are eating more food (perhaps as a result of higher levels of participation in farming). The decreased intake of fat among members of households in the NW Upolu peri-urban Region, when compared to Apia, is perhaps indicative of lower income and capacity to purchase a diet high in fat.

Gift giving at higher shares of income was found to have a significant impact on three nutrient intake regressions. The marginal effect of households spending more than the mean share of income on gifts was to reduce household member intake of calories (by 8% of mean intake), protein (by 8% of mean intake) and sodium (10% of mean intake), when compared to households spending less than the mean share of income on gifts. This variable has the largest negative impact on calorie intake and third largest on protein intake (after low income), whilst resulting in the second largest reduction in intake of sodium

of any factor (10%). The mean share of income spent on gifts to church and other households (16.8%) is a large financial outlay, and households exceeding this rate of expenditure do seem to do so at the detriment of the dietary intake of their household.

In the next section, we compare differences in the composition of diet between different sub-sections of the population.

5. Identification of major food items and food groups contributing to dietary outcomes in Samoan population, and among significant groups.

5.1 Average Samoa household food basket by food item share of household expenditure and nutrient intake

Table 17: Average Samoa household food basket (shares of household expenditure and nutrient intake)

Food Item	Expenditure	Calories	Sodium	Total Fat	Protein	Iron	Vit. A
TALO	12%	35%	1%	3%	14%	61%	10%
CHICKEN PIECES/QUARTERS	11%	6%	2%	13%	23%	4%	1%
FISH	6%	3%	3%	2%	17%	1%	8%
CANNED MACKEREL	5%	3%	9%	8%	9%	5%	20%
RICE	5%	3%	<1%	<1%	2%	1%	<1%
SUGAR BROWN	4%	8%	<1%	<1%	<1%	1%	<1%
COCONUTS (POPO)	3%	5%	<1%	19%	1%	3%	<1%
BREAD NORMAL	3%	3%	<1%	1%	3%	1%	<1%
BANANA	5%	1%	<1%	<1%	<1%	<1%	1%
INSTANT NOODLES	2%	3%	9%	5%	2%	1%	<1%
GIANT TARO (TA'AMU)	2%	2%	2%	<1%	<1%	2%	1%
COOKED LOCAL PORK	2%	<1%	<1%	<1%	1%	<1%	<1%
CANNED BEEF	2%	1%	2%	4%	2%	1%	<1%
BUTTER	1%	1%	1%	4%	2%	<1%	9%
BISCUITS - COOKIES	1%	1%	1%	1%	<1%	<1%	<1%
TURKEY WINGS	1%	1%	1%	2%	3%	1%	<1%
ICE CREAM	1%	1%	<1%	2%	1%	<1%	5%
COCOA - LOCAL	1%	1%	<1%	3%	1%	1%	<1%
SOFT DRINKS (COKE, ETC)	1%	<1%	<1%	<1%	<1%	<1%	<1%
COOKING OIL	1%	2%	<1%	6%	<1%	<1%	<1%
MILK	1%	<1%	<1%	1%	1%	<1%	2%
FLOUR	1%	2%	<1%	<1%	2%	1%	<1%
EGGS	1%	1%	<1%	2%	1%	1%	3%
CABBAGE – CHINESE	1%	<1%	<1%	<1%	<1%	<1%	5%
MUTTON FLAPS	1%	<1%	<1%	1%	<1%	<1%	<1%
BREADFRUIT	1%	1%	<1%	<1%	<1%	<1%	<1%
SAUSAGES	1%	<1%	3%	2%	1%	<1%	<1%
PUMPKIN	1%	<1%	<1%	<1%	<1%	<1%	9%
TABLE SALT	<1%	<1%	39%	<1%	<1%	<1%	<1%
TARO LEAVES	1%	<1%	<1%	<1%	<1%	<1%	5%
TOTAL	78%	84%	78%	79%	86%	85%	79%

Table 17 shows that taro (talo) represents the largest share of an average Samoan household's expenditure on food (12%). This item provides more than a third (35%) of the calories which an average household has access to, as well as almost two-thirds (61%) of household's iron intake. Taro also provides an important share of total household intake of protein (14%) and vitamin A (10%). The next three most important expenditure items are all meat products, with imported chicken pieces/quarters (11%), local fresh fish (6%) and canned mackerel (5%) all critical to the household food basket. Chicken pieces/quarters provide the most important source of protein (23%) in an average household's diet; however they also contribute a significant share (13%) of total household fat consumption. Fresh fish is the second most important source of household protein (17%), yet in contrast to chicken pieces, contributes very little to total fat intake -just 2%. Canned mackerel is the third most important source of protein (9%) but more significantly, the most important source of vitamin A in household diet (20%). However canned mackerel is also the second most important source of salt in the household food basket, contributing 9% of total sodium intake; and the third largest source of fat, contributing 8% of total fat. Table salt added for flavouring is by far the greatest source of sodium in household diets, at 39% of the total. Coconut (popo) provides the major source of fat (19%) in Samoan households' diet.

Rice is only the equal third most important source of Calories (3%) following taro, chicken pieces and fish, and fourth most important expenditure item with a 5% share. Rice also contributes far less to iron and vitamin A intake, when compared to taro. Sugar – at 4% of expenditure – contributes more calories to the average household food basket (8%) than rice, and indeed more than any other food item except taro.

Table 17 indicates that 4 of the top 10 food expenditure items are locally produced, and just 11 of the top 30 food items (by share of expenditure) are locally produced. The major source of expenditure on local fruit products is spent on banana – representing 5% of total expenditure. The most important (as a share of expenditure) locally produced vegetable products other than taro, are giant taro (ta'amu) at 2%, Chinese cabbage (1%), breadfruit (1%) pumpkin (1%), taro leaves (1%). Locally produced cocoa (1%) is another important expenditure item which – commonly combined with sugar – contributes a significant share of calorie intake.

Processed and refined products– particularly bread (3% of expenditure) and instant noodles (2% of expenditure) – are among the households most important expenditure items. Bread contributes 6% of total sodium in the average household food basket, while instant noodles contribute 9% of total household sodium intake. Local foods provide the most important source of calories (taro at 5%) and iron (taro at 61%), as well as the second (fish at 17%) and third (taro at 14%) most important sources of protein, and the third most important source of vitamin A (taro 10%).

These results indicate that while imported processed food items are far more important as a share of household food expenditure than locally produced items, local foods – particularly taro – are integral to assisting households to meet the recommended minimum nutrient intake levels.

5.2 Composition of average Samoan household diet

Figure 15 provides an overview of the contribution of the major food groups (i.e. meat, vegetables, bread and cereals, fish, fruit, etc) to household diet. This method of analysis provides a point of comparison to Table 16 which illustrated the share of the Top 30 food items (ranked by order of importance as a share of household expenditure) to diet.

Figure 15: Average Samoan household diet by share of expenditure, food group type and volume

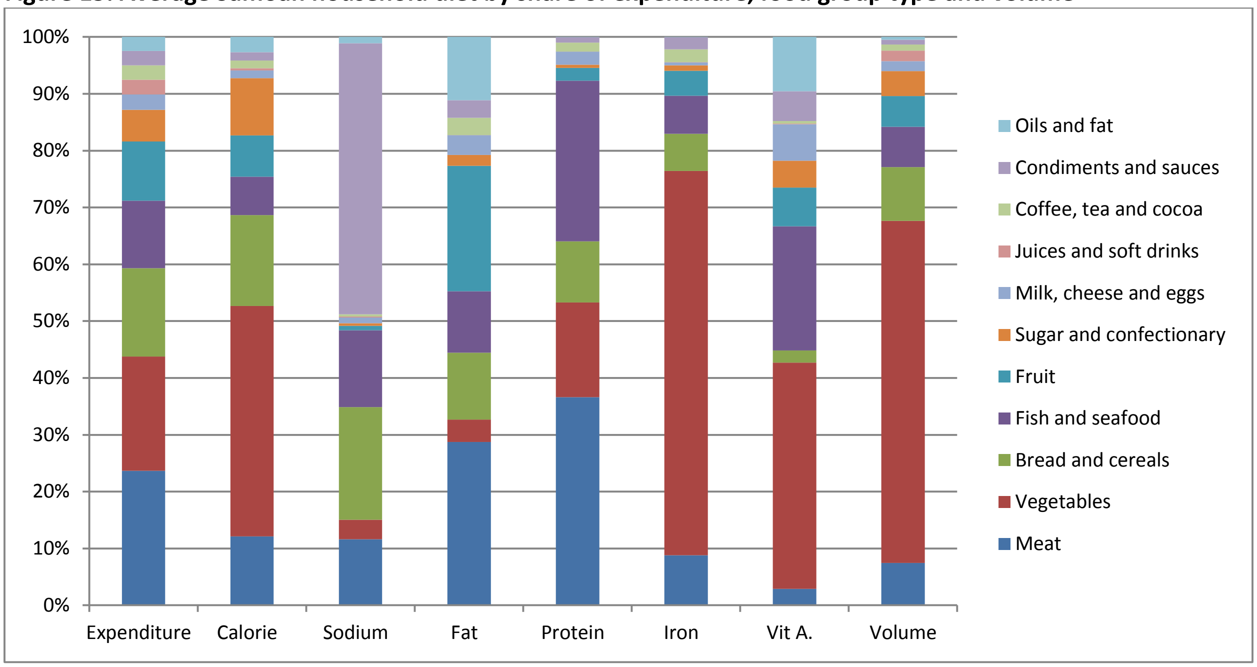
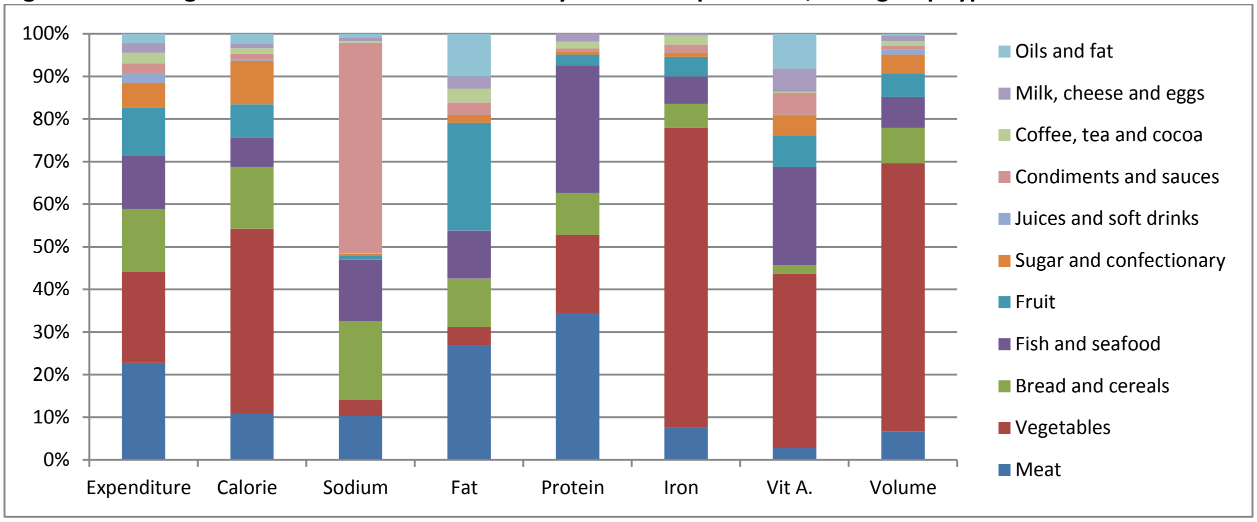


Figure 15 illustrates that by volume, vegetables (including taro, ta'amu and breadfruit) represent more than 60% of household food intake, with bread and cereals 9%, followed by meat and fish at 7% each. On average, meat products represent the largest category of food expenditure among Samoan households (24%). However, vegetable– largely taro, as indicated by Table 17 – are the most important source of household calories (41%). Meat products provide the largest share of fat (29%), with fruit – largely coconut (popo) – contributing the second most (22%) to total household fat intake, by food category. Meat products also provide the largest source of protein (37%), followed closely by fish and seafood products (28%). Condiments – largely table salt – provide almost half the sodium (48%) in average Samoan household diets, with bread and cereals (including instant noodles) second most important (20%), followed by fish and then meat. Vegetables provide more than two thirds (68%) of household iron intake, supplemented by iron from meat and fish consumption. Vegetables provides some 40% of household vitamin A consumption, followed by fish and seafood products (22%) as well as fats and oils (10%), largely provided by household butter consumption.

The following figures will present an overview of these consumption shares, and compare how they change, among the different sub-population groups explored in the descriptive tables (9-15).

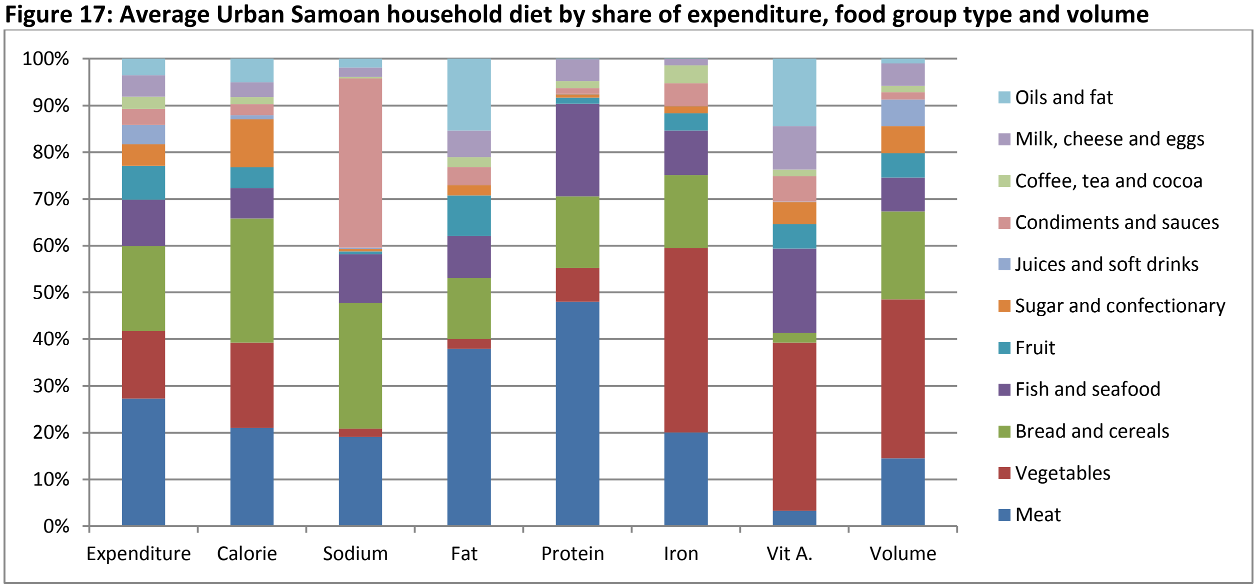
5.3 Comparison of the composition of average Samoan rural and urban household diets

Figure 16: Average rural Samoan household diet by share of expenditure, food group type and volume



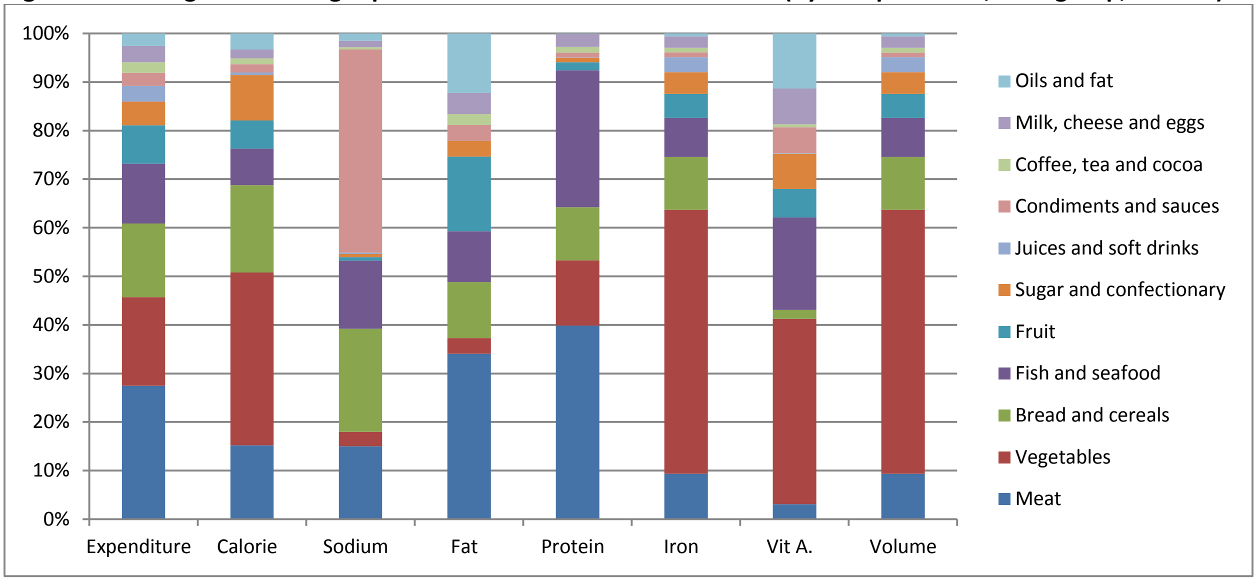
A comparison of Figures 16 and 17 reveals that meat represents a large difference in contribution of meat and vegetable consumption to household expenditure and nutrient intake among rural and urban households. Vegetables represent far more of the volume of consumption among rural households than among urban households, whilst meat is double the volume among urban consumption than compared to rural households. Rural households get almost three times the share of their calories from vegetables than urban households. Urban households get almost double the calories from bread and meat than from vegetables, when compared to rural household diets. Urban expenditure on juices and soft drinks, oils and fats, and dairy products is more than double rural household expenditure, whilst expenditure on fruit products is half that of rural households. As a result meat provides households in urban areas with half their protein and more than a third of fat intake, while fish, vegetables and fruit are more important providers of these nutrients in rural household diets. Oils and fats are a more important source of vitamin A in urban than rural diets, though vegetables and fish remain the most important sources. Vegetables provide more than two thirds of iron in rural diets – almost double the share in urban diets.

Figure 17: Average Urban Samoan household diet by share of expenditure, food group type and volume



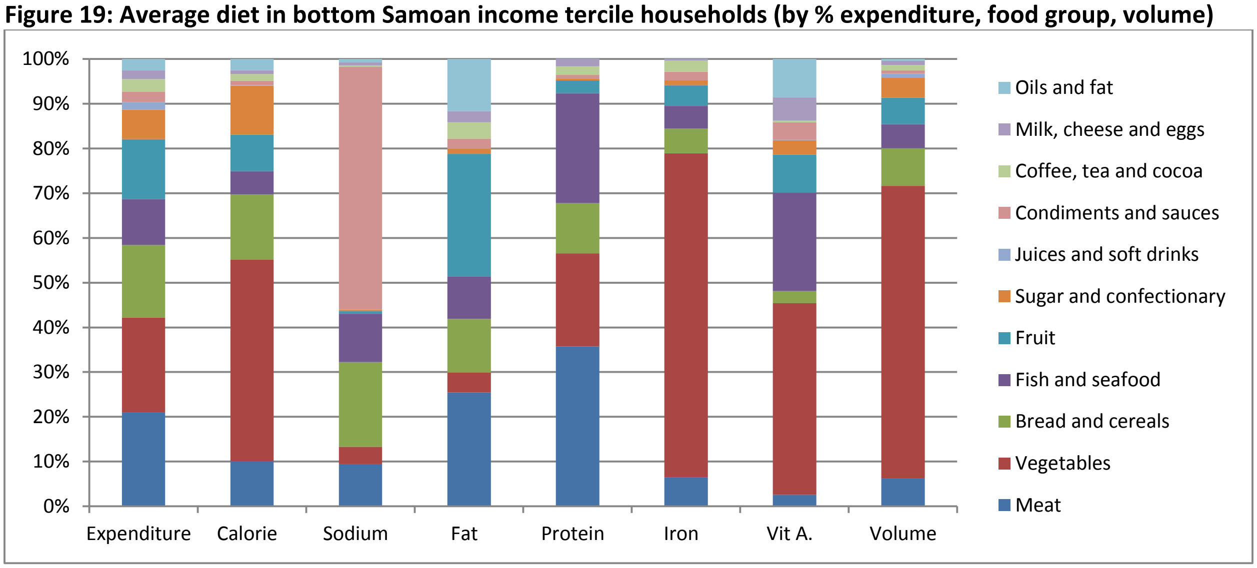
5.4 Comparison of the composition of diet among households with different income levels

Figure 18: Average diet among top Samoan income tercile households (by % expenditure, food group, volume)



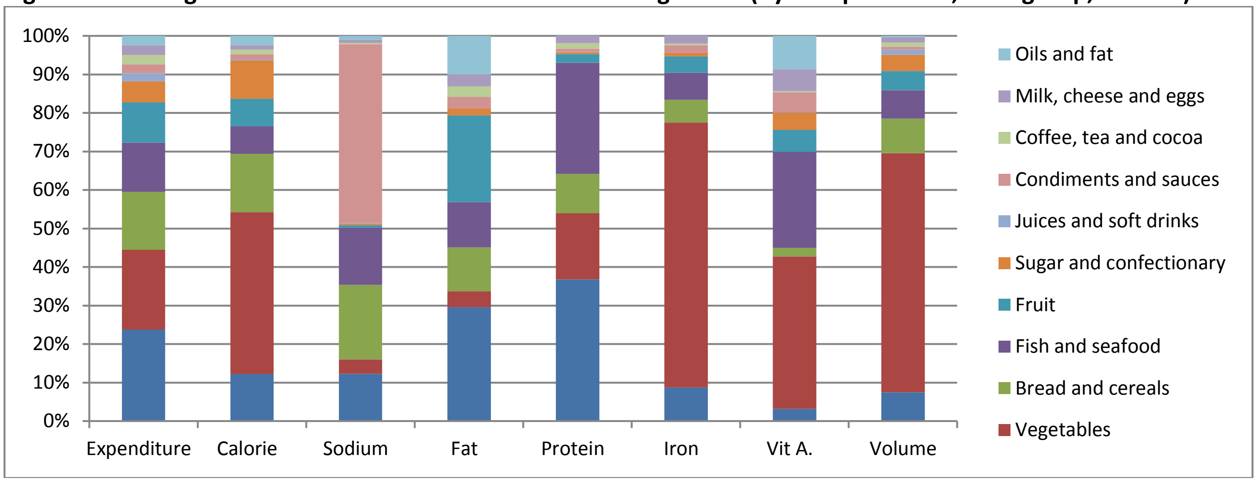
A comparison of Figures 18 and 19 reveals that households in the bottom income tercile consume far more vegetables than households in the top income tercile as a share of the total volume of food intake; and spend far less on meat than households in the top income tercile. Vegetables therefore provide a greater share of calories to households in the bottom tercile, than households in the top tercile. Meat provides a more important share of fat among households in the top income tercile than households in the bottom tercile. Fish and seafood products are slightly more important as a share of expenditure for top income tercile households, and bread and cereal consumption less important, with the result that households in the top income tercile obtain more protein from meat and fish products than households in the bottom income tercile. Households in the top income tercile obtain iron and vitamin A from a far more diverse range of food categories than households in the bottom tercile, who depend far more on vegetables to provide these critical microntutrients. Condiments (including table salt) are also more important in explaining household sodium intake among those households in the bottom income tercile.

Figure 19: Average diet in bottom Samoan income tercile households (by % expenditure, food group, volume)



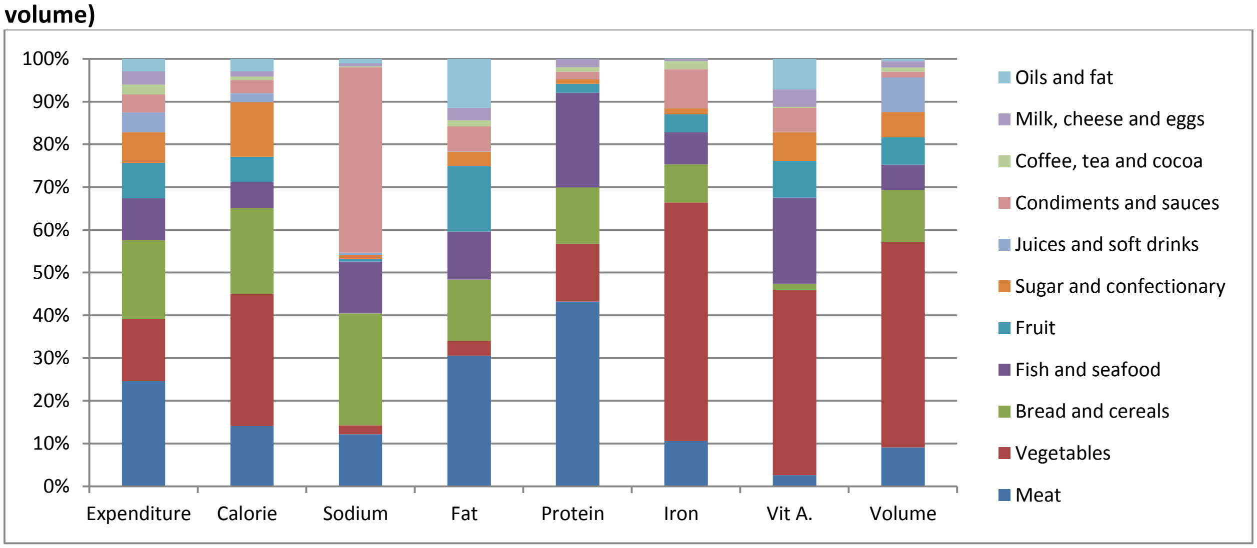
5.5 Comparison of the composition of diet of households headed by adult aged 60+ with adult aged less than 30 years old

Figure 20: Average Samoan household diet where head is aged 60+ (by % expenditure, food group, volume)



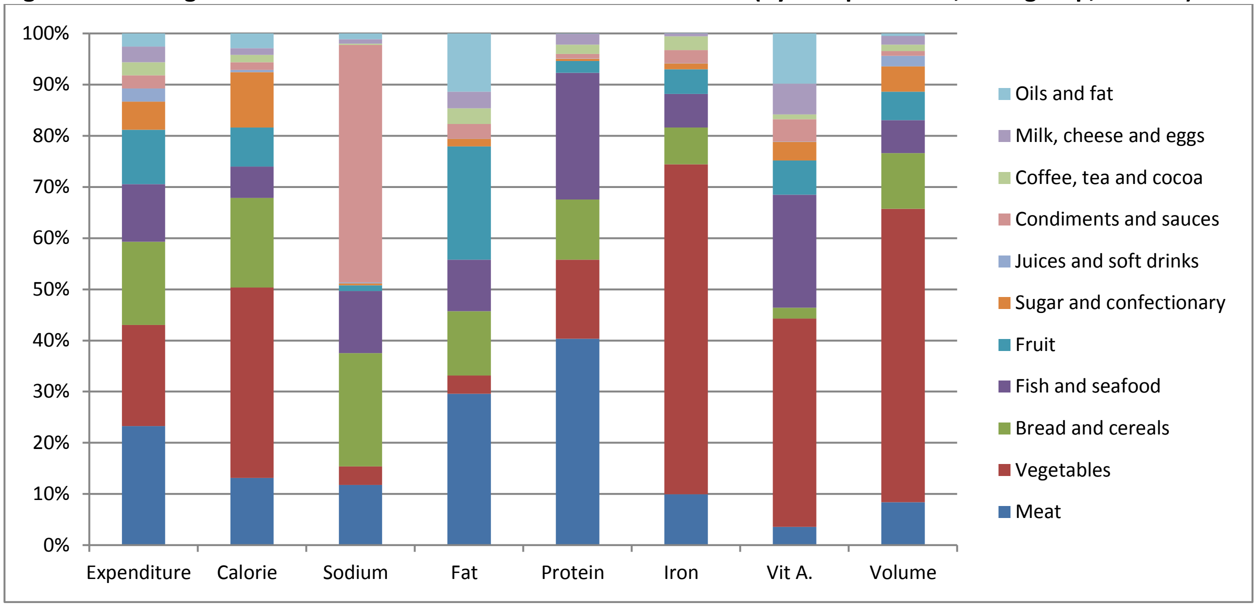
A comparison of Figures 20 and 21 reveals that households headed by individuals aged 60 or more consume far more vegetables as a share of the total volume of consumption than households headed by younger (less than 30) adults. Households with younger heads spend more on meat and bread/cereal products, and less on fish and seafood as well as fruit products. Vegetables were therefore a more important source of calories among households with older household heads. However meat remains the most important item by share of expenditure among both sets of households. Households with heads aged 30 or less obtain more of their protein and fat from meat consumption, while households with heads aged 60+ derive a greater proportion of protein and fat from fish and seafood, as well as fruit. Bread and cereals contributes more to sodium consumption among younger household heads. Younger household heads get more iron from meat and fish/seafood products than older household heads; while fish and seafood provides households with older heads more vitamin A. Households with younger heads spent far more on soft drinks, oils and fats, and condiments than those with older household heads.

Figure 21: Average Samoan household diet where head is aged 30 or less (by % expenditure, food group, volume)



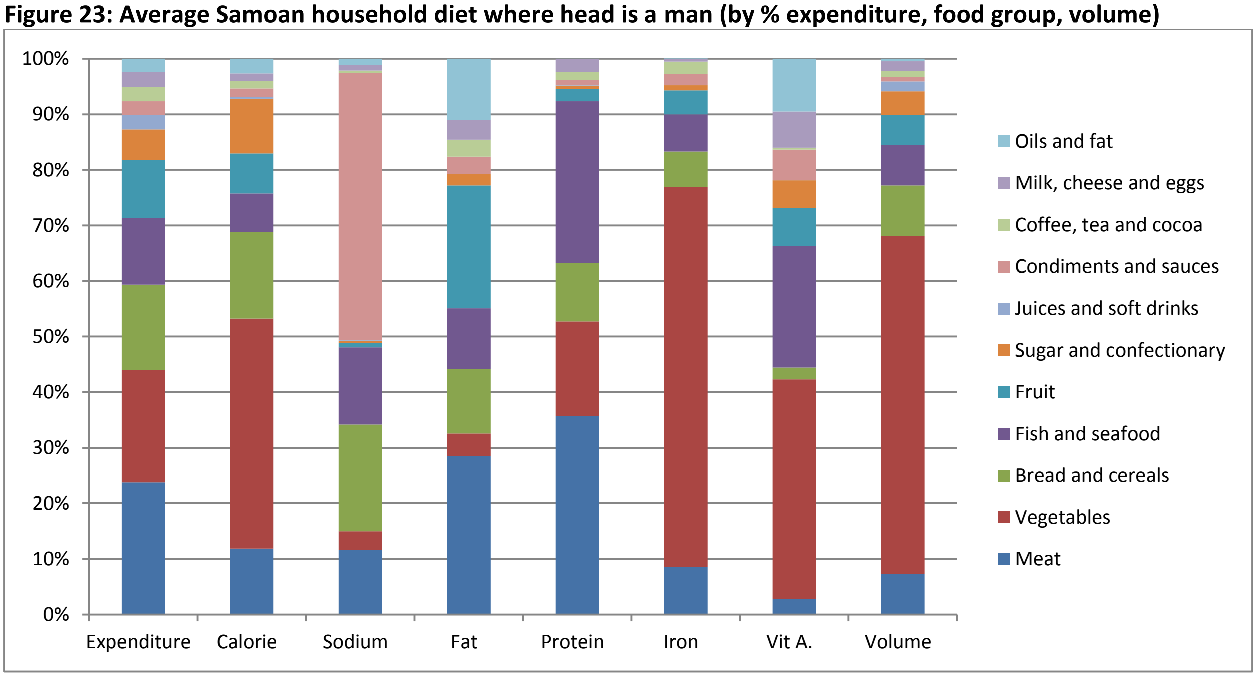
5.6 Comparison of the composition of diet of households headed by men and women

Figure 22: Average Samoan household diet where head is a woman (by % expenditure, food group, volume)



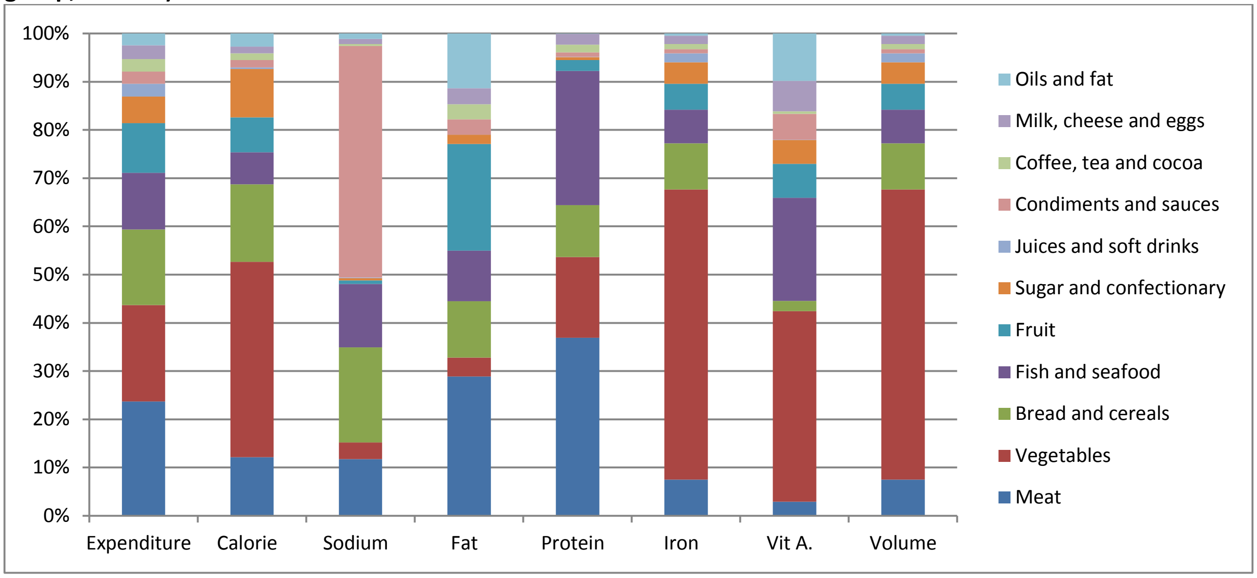
A comparison of Figures 22 and 23 reveal that there is not a huge difference in the composition of diet (by food group type) between male and female headed households. Households headed by women spend slightly less on meat as well as fish and seafood, than male headed households. They also spend more on bread and cereals, more on fruit, more on fats and soils, but less on sugar and confectionary. A greater share of the volume of dietary intake in households headed by women comes from bread and cereals, and less comes from vegetables, than male households. Households headed by men access protein and fat from a slightly broader source of food group types (meat, vegetables and fruit, and fish and seafood) than households headed by women, who are more dependent on meat products and bread and cereals. Iron intake in households headed by women is slightly more diverse, however.

Figure 23: Average Samoan household diet where head is a man (by % expenditure, food group, volume)



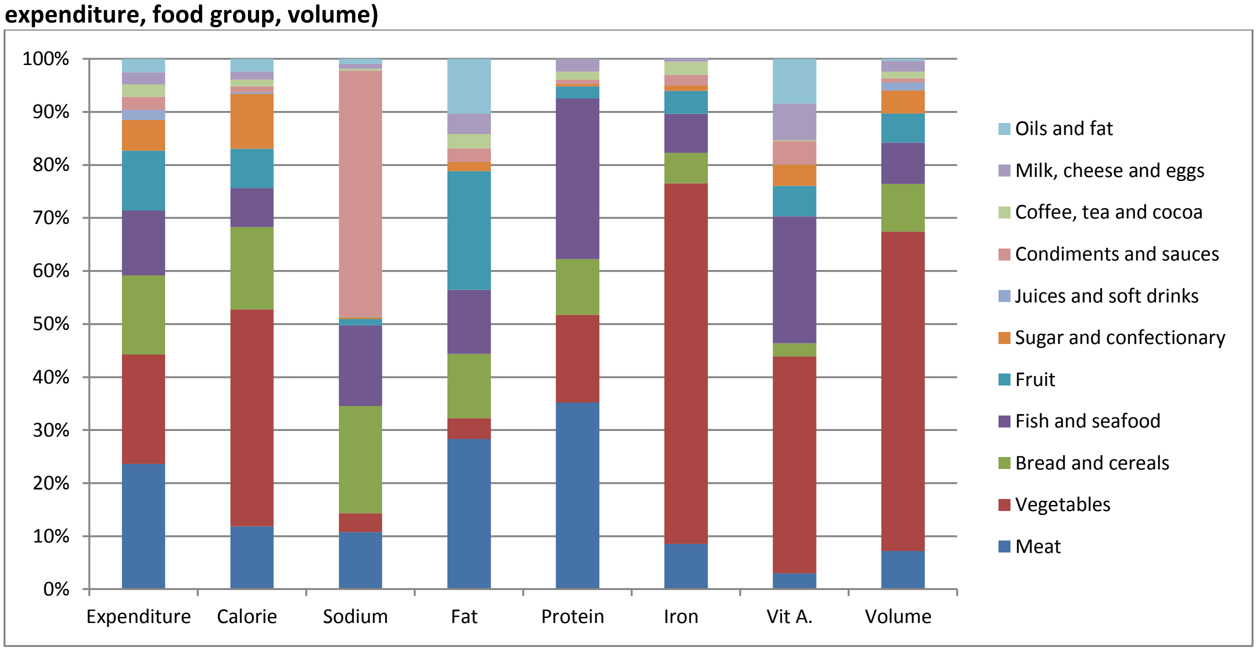
5.7 Comparison of the composition of diet of households headed by adult with post-primary educational attainment, and without this level of education

Figure 24: Average Samoan household diet where head has a post-primary education (by % expenditure, food group, volume)



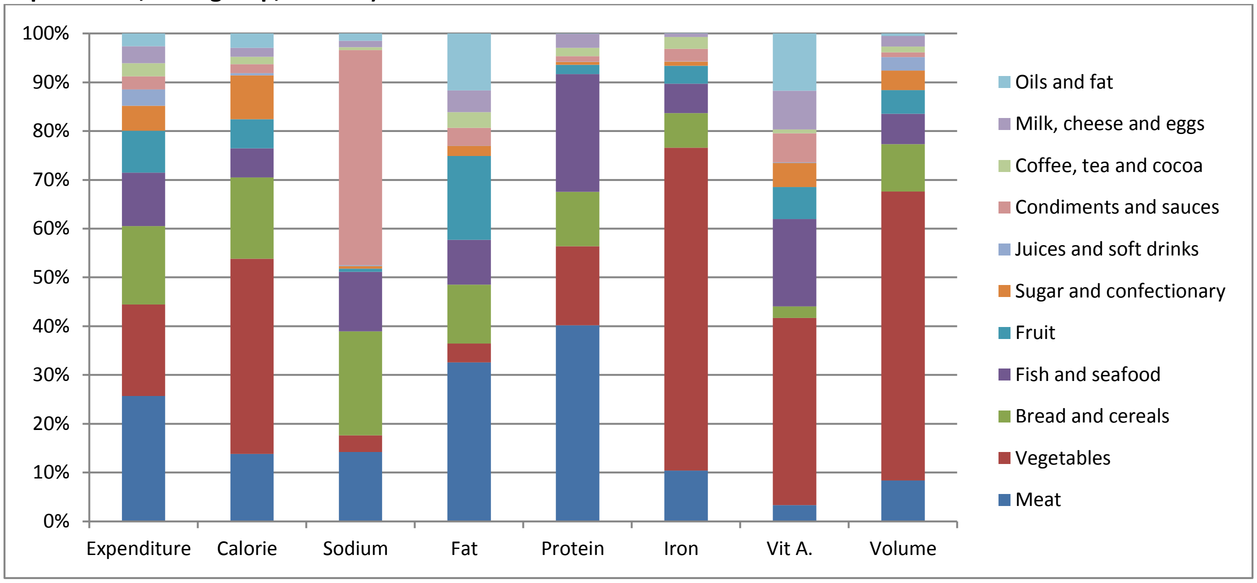
A comparison of Figures 24 and 25 reveals that there is very little difference in the composition (by food group) of the diet of households with and without a post-primary educated household head. Households without a head educated at a post-primary level spend slightly more on vegetables, and slightly less on bread and cereals. They spend more on oils and fats, and less on milk, cheese and dairy products. They spend less on fruit, but also slightly less on sugar and confectionary. They get slightly more protein, vitamin A and fat from fish and marine products than households with more educated heads.

Figure 25: Average Samoan household diet where head does not have a post-primary education (by % expenditure, food group, volume)



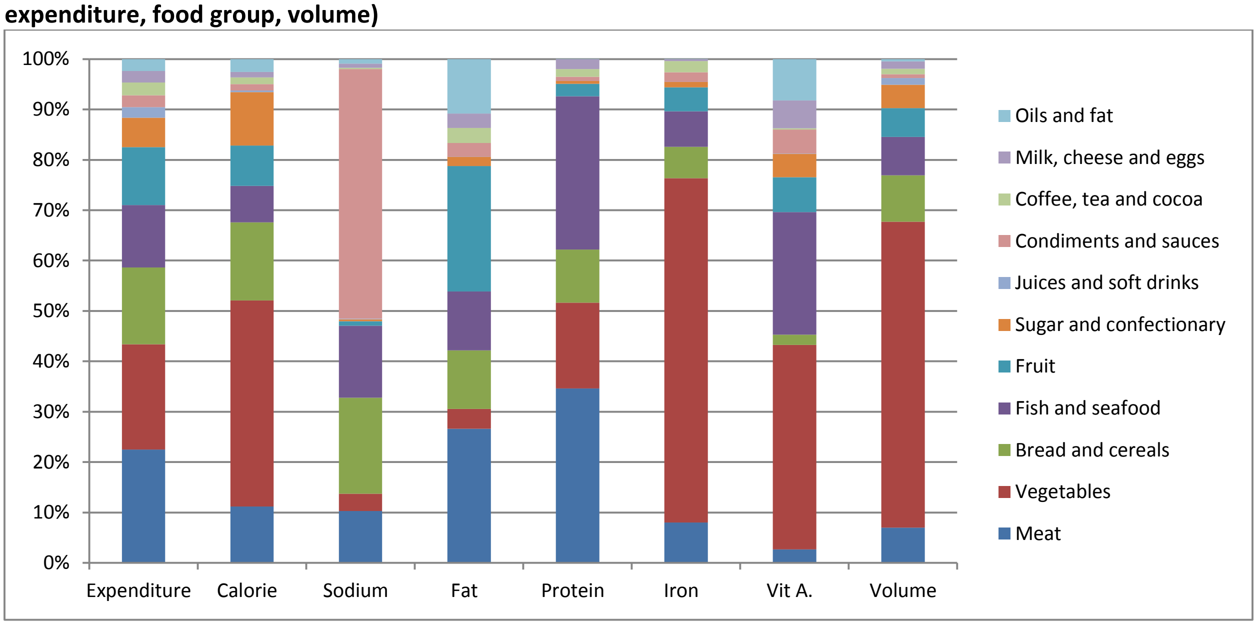
5.8 Comparison of the composition of diet of households where share of income spent on gifts is greater than mean share

Figure 26: Average Samoan household diet where share of income spent on gifts above the mean share (by % expenditure, food group, volume)



A comparison on Figures 26 and 27reveals that there are only minor differences between the compositions of household diet (by food group type) between households that spend more than the mean share of income on gifts, than those below. Households 'above the mean' spend slightly less on vegetables, fruit, fish and seafood, as well as sugar and confectionary; but more on bread and cereals, meat and dairy products. Thus slightly more of their fat and protein comes from meat, and less from bread and fish.

Figure 27: Average Samoan household diet where share of income spent on gifts below the mean share (by % expenditure, food group, volume)



6. Establishing a Nutritious Food Basket for Samoa

Identifying the lowest cost basket of food items which also helps households satisfy the recommended intake levels for important micro and macronutrients, would help national authorities identify the required level of per capita and household income required to purchase an adequate diet. This could be used to monitor poverty, and to establish minimum wages. It can also be used to develop programme and policy interventions in order to improve access or reduce cost to food items identified as being the most efficient source of missing macro and micronutrients among at risk populations.

While this study has examined the characteristics of deficiencies in nutrient intake in the Samoan population for 6 micro and macronutrients (calories, fat, protein, sodium, iron and vitamin A) an adequate diet would be one that satisfies the recommended daily intake values for a far wider range of nutrients, including: carbohydrates, Total Dietary Fibre (TDF), magnesium, potassium, zinc, vitamin C, vitamin E, vitamin B12, niacin, riboflavin, thiamin and calcium.

Table 18 below illustrates the minimum recommended minimum nutrient intake required per day, per adult equivalent, for each of these new nutrient factors. These were added to the required intake values for Calories, fat, protein, sodium, iron and vitamin A (Table 8)

Table 18: Recommended daily intake of additional macro and micronutrients included to establish the minimum cost of a nutritious food basket capable of providing one (adult male) Samoan persons nutrient needs

Nutrient	RDI
Thiamin (mg/day)	1.2
Riboflavin (mg/day)	1.3
Niacin (NE mg/day)	16
Vitamin B12 (µg/day)	2.4
Vitamin C [(d)] (mg/day)	45
Vitamin E (mg/day)	10
Zinc* (mg/day)	14.1
Total Dietary Fibre (g/day)	30
Magnesium (mg/day)	260
Calcium (mg/day)	1000
Potassium(mg)	1710
Total carbohydrates (g/day)	450

Source: FAO/WHO (2011)

6.1 The optimal food basket

To identify a low-cost bundle of food that meets all the daily recommended nutrient intakes and the total cost of purchasing that bundle, we used the dataset to establish the average unit cost and nutrient composition of the Top 50 food items, for 10 different micro and macronutrients: calories, fat, protein, carbohydrates, Total Dietary Fibre (TDF), sodium, iron, calcium and vitamins A and C and fed it into the linear programming method described in section 2.10 (and Annex 3). Given the limitations of the programme, we were not able to include values for all 18 nutrients (Table 8 and Table 18). The results of this method are presented in Table 19.

Table 19: Minimum cost (WST) and food intake (g) required to meet macro and micronutrient thresholds[65]

Food item	WST/kg*	Purchase quantity (g)	Consumption quantity (g)**	Expenditure (WST)	Required decrease (WST/kg)	Required decrease (% change)	Allowable Increase (WST/kg)	Allowable increase (% change)
Taro	1.11	1107	908	1.23			0.69	62.1%
Chicken pieces	7.50	445	271	3.34			0.25	3.3%
Pumpkin	2.90	189	129	0.55			0.34	11.7%
Bread	6.98	186	186	1.30			0.25	3.5%
Coconuts (popo)	0.90	105	25	1.29			1.66	184.4%
Canned mackerel (eleni)	10.50	83	83	0.87			1.41	13.4%
Paw paw	1.40				0.24	17.1%		
Turkey wings	9.90				0.66	6.6%		
Ta'amu (Giant taro)	2.30				0.78	33.9%		
Flour	5.00				1.17	23.4%		
Sausages - beef	14.80				1.73	11.7%		
Breadfruit	2.80				1.96	70%		
Pancake	5.60				2.15	38.3%		
Onion	3.10				2.23	71.9%		
Cucumber	3.90				3.20	82.1%		
Chinese cabbage	6.40				3.60	56.2%		
TOTAL		**2097**	**1602**	**7.33**				

*Note: The unit prices included in the model to produce the results in 19 are derived from the average unit price records. However there is significant variation in the price of locally produced products depending on whether these items are produced by the household (and therefore households pay only the equivalent of a 'farm gate' gate price) or procured from the market (where households pay a higher 'market price'). Therefore it is conceivable that households in rural areas or households producing these items for own consumption, would face a lower unit price than the average unit price given here.
** Note: Consumption quantity is calculated from the purchased quantity volume by applying Edible Portion. The nutrient contribution of each food item is calculated from the consumption, rather than purchased quantity. The edible portion ratio's for fresh produces are explored in more detail in Annex 3.

Table 19 indicates that households could meet all their food energy requirements (3669 kcal with the right proportions from fat, carbohydrates and protein) and all their micronutrient requirements (vitamin A, vitamin C, iron, calcium, TDF and sodium) by consuming 2097 grams (or 2.1kg) per day of by purchasing set quantities of just six food items: taro, chicken pieces, pumpkin, bread, coconuts and canned mackerel. The per capita daily quantities to be consumed, based upon the edible portion of the purchased quantity, is presented in Table 19: 908g of taro, 271 grams of chicken pieces, 129 grams of pumpkin, 186 grams of bread, 25 grams of coconut cream and 83 grams of canned mackerel. The cost

[65] For 10 important micro and macronutrients: calories, fat, protein, carbohydrates, Total Dietary Fibre (TDF), sodium, iron, vitamin A, vitamin C and calcium.

of this optimal basket of goods would be WST7.33 per day, indicating that the minimum cost of a diet that met all of the food energy and nutrition needs of an adult male in Samoa, would cost US$3.23 a day (in 2013 prices).

Whilst these quantities of the six food items selected in Table 19 would satisfy an individual's recommended food energy and nutrition needs for the 10 selected macro and micronutrients, a small change in the price of these items or those of potential substitutes, would have a significant impact on the food items or quantities included in the optimal basket of goods.

Columns 7 and 9 of Table 19 indicate (respectively) the percentage price decreases and increases required, by food item, for the composition of optimum food basket to change. Column 9 indicates that the price of taro would need to increase 62.1% before it would be substituted out of the optimum food basket and replaced with an alternate food item. While the price of taro does fluctuate throughout the year, the variation from the average unit price is within this range. In contrast, the price of chicken pieces would only need to increase by more 3.3% and bread by 3.5%, before they would be substituted out of the optimum basket in favour of cheaper alternatives. Similarly, pumpkin and eleni (canned mackerel) could only undergo a small price rise 911.7% and 13.4% respectively) before they would be substituted from the optimum food basket. Table 19 indicates that the price of coconuts could rise 184% without being substituted out of the optimum basket. Column 7 indicates that a small (6.6%) decrease in the average price of turkey wings would see that item substituted into the optimum basket; whilst the price of sausages would have to decrease by 11.1% to be substituted into. Among the locally produced goods, a decrease in the price of paw paw by 17.1% and by 33.9% for ta'amu, would see these food items substituted into the optimum basket. Breadfruit, onions, cucumber and Chinese cabbage would all have to undergo price reductions greater than 50% of their present price before these would be substituted into the optimum food basket, based on their nutrient composition.

The relative cost efficiency of food items in delivering macro and micronutrients revealed by this model should be a focus of food policy. The cost of an 'optimum basket of goods' is higher in US dollar terms than the 'Cost of Basic Needs' Food Poverty Line (FPL) established for Samoa (UNDP 2015), which established a minimum requirement of 2100/2200 calories per adult male per day at a cost of WST4.93 or US$2.17 (using 20013 exchange rates)[66] . However one could argue that – in order to assess the adequacy of the food items and imputed diet which a household has access to – it is important to establish the cost of a basket of goods based on calorie requirements that take into consideration the real activity levels of an average Samoan household member, as well as the other nutrient requirements essential to a healthy life.

It is important to note that while this food basket may represent the 'optimal' bundle of goods – providing the most efficient means of reaching the required nutrient intake levels without exceeding the maximums – it may not satisfy all the dietary requirements, as well as one that is practical or preferential in the eyes of many consumers. An adequate diet should not depend on just 6 items, given

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[66] Based on 2013 average exchange rate of 1USD=2.269 WST source from Oanda http://www.oanda.com/currency/historical-rates/ accessed on 24/11/2015

the potential impact of disruptions to food production or marketing, or rapid price changes, on dietary intake and therefore the food security of the household. Similarly a nutritionist would recommend that an adequate diet would be one satisfying the nutrient intake levels for more than the 10 nutrients examined by the model. In addition, food items are not readily available for purchase or easily prepared for consumption in the exact quantities specified here, i.e. 129g of pumpkin per person per day, and therefore future models could make use of set serving sizes or marketed quantities. However, despite these challenges, this 'optimal food basket' represents a first step towards identifying the real cost of an adequate diet in Samoa. Linear modeling does offer a method for identifying the cost, quantity of intake and composition of a food basket which meets the full range of macro and micronutrient thresholds, and provides the required variety and practical portion size. This should be undertaken, in partnership with national stakeholders.

Whilst the selection of an optimal basket of food items (with allowances made for substitution based on price changes) is important to help national authorities prioritize interventions around the food items that will help Samoa's population maintain a healthy diet, adopting and monitoring the cost of a Nutritious Food Basket that includes a wider variety of food commodities would be more beneficial than focusing only on these 'optimum' food items.

This policy option will be explored along with other potential policies and programme interventions in the next section.

7. Policy implications and potential interventions

Policies to create a healthier food environment have been recommended for future action in the National Nutrition Policy. FAO promotes three main categories of country level actions in order to improve access to low-cost nutritious foods: 1) trade and market related measures; 2) measures to facilitate access to affordable food by consumers; and 3) measures to increase food production.

Trade and market related measures

Facilitating improvements in post-harvest handling and marketing efficiencies in order to reduce the cost of locally produced goods high in iron, vitamin A and protein (taro leaves, pawpaw, giant taro, eggs) in urban areas, will also be critical to encouraging substitution of these items into their diets.

High rates of losses due to poor post-harvest handling practices (from on-farm to transportation to market) and storage also drive up the prices of locally produced goods for consumers. Current postharvest handling practices within commercial horticultural value chains in Samoa result in significant levels of qualitative and quantitative losses: commonly 12-15%, increasing up to 59% after three days of commercial market storage.[67] Simple advice on proper harvesting techniques (time of day for harvesting, crop cooling with water etc.) and appropriate packaging for transport (e.g. reusable plastic crates), together with some strategically placed cool holding facilities (e.g. solar cooled reefer containers) could significantly enhance product shelf life and quality. The lack of cold storage facilities available to farmers and shipping agents significantly increases post-harvest losses. Recognizing the high cost and unreliability of mains power, purpose adapted reefer containers with solar generated power would seem to be a worthwhile option for provision of cool storage facilities. While several commercial companies offer custom made products these could also possibly be fabricated from second-hand reefer containers in-country.[68]

Farmer organizations can also help reduce the final cost of locally produced goods for consumers, by engaging in group marketing strategies which reduce the unit cost of transporting goods.[69] However farmer organizations in remote rural areas traditionally face a large number of organizational issues which require significant investment in capacity building to address.[70] Farmer organizations in the Pacific Islands and Samoa face many challenges, and will require ongoing, committed support from technical agencies in order to help small farmers improve their linkages to market, in an effort to reduce the final cost of locally produced goods for consumers.

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[67] FAO (2015) *Post-harvest loss and food safety risk in Samoa's fruit and vegetable value-chains*, FAO Sub-Regional office for the Pacific: Apia

[68] FAO (2015) *Vanuatu fruit and vegetable sector value chain analysis*, FAO Sub-Regional office for the Pacific: Apia

[69] Barrett C. (2008) "Smallholder market participation: concepts and evidence from eastern and southern Africa," *Food Policy* 33(4): 299-317

[70] Chirwa. E *et al.* (2005) "Walking tightropes: supporting farmer organisations for market access," *Natural Resource Perspectives* no. 99, Department for International Development

Local authorities could reduce the cost of marketing local produce and therefore prices faced by consumers by reducing the market fees levied on managers of market stalls, as well as reduce or relax legislation which may prevent retail of local produce outside of designated markets. Similarly efforts to reduce the freight costs associated with marketing local produce from outer islands could also help make these products more competitive on domestic markets, and improve access to nutritious local food products.

Changes in trade policies can also have a significant impact on price. The liberalization of tariffs on imported foods has reduced the price of many energy dense but nutritionally poor convenience foods, relative to local substitute products; and therefore increased the economic incentives to increase the consumption of these imports.[71] The strategic use of tariffs and excises to increase the price of food items identified as contributing to poor health outcomes, such as food products high in sodium, sugar and fat, could help to reduce the economic incentives to consume these items and encourage households to consumer healthier substitute products. Research to date suggests that a tax on sugar-sweetened beverages (SSB) has had strong positive effects on reducing consumption.[72] As of September 2014, there was evidence that SSB taxes have been adopted in ten of fourteen Pacific Island Countries, with the most commonly taxed beverage being carbonated soft drinks.[73] The use of excise taxes is preferred than the application of import levies, as the WTO's General Agreement on Tariffs and Trade (GATT) prevents imported products from being taxed in excess of like domestic products. Countries are replacing lost revenue with other domestic taxes, such as excise taxes, and/or VAGST, sales and goods and services taxes.[74] Health-related taxes are unlikely to be a problem if they are applied equally to domestic and imported products, if import duties are not greater than what has been agreed as the upper limit[75] and there is a health justification.[76] Excise taxes are an established mechanism for taxing alcohol and tobacco in the Pacific Islands, and therefore extending this model to cover food and beverages would involve minimal additional administrative costs. The European Union has developed a number of options for profiling the nutrient content of food and beverages in order to be able to assess them for policy, which could be adapted for Samoa.[77] Modeling work done by the OECD has indicated that the application of a health excise tax on less healthy food choices, combined with subsidies of healthier alternative products, could be an effective way to change diets and health outcomes.[78] Economic modeling of the impact of the introduction of a 20% excise on food items identified through nutrient profiling as 'unhealthy' in order to encourage substitution towards healthier products,

[71] Thow *et al.* (2011) *Op. Cit.*
[72] Brownell *et al*. (2009) *Op. Cit.*
[73] FAO (2015) *Food Matters: policy options for strengthening food and nutrition security in the Pacific islands*, FAO Sub-Regional Office for the Pacific: Apia
[74] Thow *et al.,* (2011) *Op. Cit.*
[75] C-POND, SPC, UNDP, World Health Organization (WHO). Trade, trade agreements and non-communicable disease in the Pacific Islands. Intersections, Lessons Leaned, Challenges and Ways Forward. In: Workshop on "Trade, Trade Agreements and Non-Communicable Diseases." Nadi, Fiji Islands; 2013
[76] Thow *et. al* (2011) *Op. Cit.*
[77] Drewnowski A, (2007) "What's next for nutrition labeling and health claims: an update of nutrient profiling in the European Union and the U.S." *Nutrition Today* **42**:206–14
[78] Sassi F, Belloni A, Capobianco C (2013) "The Role of Fiscal Policies in Health Promotion", *OECD Health Working Papers*, No. 66, OECD Publishing

undertaken in 2015 by the WHO and FAO in partnership with Samoan Ministry of Health, identifies that this policy would result in a reduction of daily sodium intake of more than 106mg, and fat intake of 4.4 grams.

Introducing regulations requiring the fortification of bread and rice with vitamin A and other micronutrients could also help to improve nutrition outcome in Samoa. While fortified flour and foods manufactured from fortified flour, are available throughout the Pacific, only Fiji operates a systematic fortification policy. An evaluation of Fiji's iron fortification programme indicated that this has successfully reduced anemia amongst at risk populations.[79] One approach is for Samoa to adopt deliberate and mandatory fortification regulations in order to ensure flour and rice products sold nationally are fortified with vitamin A and iron.[80] There is a small increase in price associated with rice fortification, with experience thus far in 15 countries, indicating that the retail price increase for fortified rice ranges from an additional 1% to 10%.[81] Given the potential to reduce Vitamin A deficiencies among at risk populations further investigation of the cost effectiveness and practicalities of mandatory rice fortification should be explored.

In addition introducing regulations to specify the maximum sodium or fat content to be included in manufactured food products could be effective at reducing sodium and fat intake. This would be particularly effective where that food is manufactured locally, such as for bread products. However this regulatory approach may be less effective when those food items are manufactured in other jurisdictions. In addition the costs of inspecting and enforcing compliance may introduce a substantial burden for the Samoan public service.

Measures to increase access to affordable and nutritious food by households

This paper has identified that urban households and households with large numbers of dependents need targeted measures to improve access to fresh fruits, vegetable and meat products high in vitamin A and iron. Safety net programs that provide cash transfers or food vouchers to at risk consumers, have been adopted in many countries around the world. However for low-income developing countries, there are often few available resources with which to provide these transfers, and little experience of delivering these effectively to targeted consumers.[82] Some initial trials have already begun in the Pacific Islands (principally in Samoa and Fiji) with the use of mobile-phone based 'mobile money' schemes for transferring to identified households, vouchers redeemable for particular pre-approved goods (such as building supplies) from selected retailers, as part of a post-disaster response. Utilising these schemes might offer a model with few administrative costs and proven capacity to deliver benefits to targeted households, for facilitating transfers to households in food energy and nutrition deficit. However,

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[79] Clarke, D. *et al* (2012) *A study on the regulatory requirements for food fortification in the Pacific*, WHO: Suva
[80] Beretta Piccoli N, Grede N, de Pee S *et al.* (2012) "Rice fortification: its potential for improving micronutrient intake and steps required for implementation at scale," Food Nutrition Bulletin 33(4):360–372
[81] Roks E. (2014) "Review of the cost components of introducing industrially fortified rice," New York Academy Science Annual 1324:82–91
[82] FAO (2011) *Op. Cit.*

foreign support will have to be mobilized to enable Samoa to cope with the increased demand on their budgets that such a voucher system would entail.

Similarly, policy-makers in the developing world have identified that school-feeding programs can ensure that students facing poor educational and nutritional outcomes receive the minimum nutritional inputs they require to lead healthy and productive lives.[83] International experience also indicates that these programmes can improve the supply quality and quantity capacity of small farmers, reducing the cost of healthy eating through bulk procurement arrangements and the use of forward contracts which facilitate scale efficiencies. However experience on school feeding programs from elsewhere in the Pacific, indicates that little attention is currently paid to providing nutritious meals, or securing supply from local farmers. Therefore, it would be important for Samoa stakeholders to adopt a programme for school meals that is based on a menu that incorporates local fresh produce (fruits, vegetables and livestock products) to the maximum extent possible. It will be necessary to design a procurement and distribution system to facilitate the purchase of such foods from local farmers and fishers. The school lunch menu should be drafted with the technical advice of nutrition experts and should maximize the use of local food varieties that are rich in vital nutrients. The government agencies that are responsible for the procurement of school lunches should collaborate with local farmers and their associations to encourage the planting and marketing of these essential crop varieties.

The cost of providing free or subsidized meals to school children is a significant potential barrier. There is a compelling case for investment in the establishment of school feeding programs that help to get children into school and help keep them there, however, through enhancing enrolment and reducing absenteeism. Once the children are in school, the programs can contribute to their learning, through avoiding hunger and enhancing cognitive abilities[84] [85]. On this evidence, Samoa stakeholders could demonstrate the benefits of a school feeding model through the implementation of pilot schemes targeting a small number of schools containing high populations of students at risk of poor nutrition outcomes. This could help build support for a more widespread program of school feeding.

Establishing a Nutritious Food Basket (NFB) will help to establish a measure of the cost of basic healthy eating that represents current nutrition recommendations and average food purchasing patterns in Samoa, to replace the Cost of Basic Needs (CBN) approach to measuring food poverty. This basket would be designed to reflect an example of an eating pattern that meets the minimum and maximum recommended nutrition thresholds (ADER, RDI and UL) established for Samoa, and outlined in this report. This could be established through a linear modeling approach, working with Health sector stakeholders to establish a food basket which satisfies the requirements of offering an adequate, as well

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[83] World Food Programme (2013) *Home Grown School Feeding: A Framework to Link School Feeding with Local Agricultural Production*, WFP, Rome

[84] Bundy D, Burbano C, Grosh M, Gelli, A, Jukes M, Drake L (2009) Rethinking school feeding: Social safety nets, child development and the education sector. Directions in Development. Human Development, World Bank

[85] Adelman S, Gilligan D, Lehrer K (2008) How effective are food for education programmes? A critical assessment of the evidence from developing countries, Washington, DC, International Food Policy Research Institute

as varied and food secure diet. Systemic monitoring of both the affordability and accessibility of foods on this list could help improve nutrition intake amongst at risk households.

Other complementary policy interventions focused on educating consumers about dangers of adding table salt and sugar to meals and beverages could also provide added value to the policy interventions outlined here.

Measures to increase food production

The fall in productivity in the rural sector in PICs has been a key contributor to the increase in the price of domestic foods that are of nutritious value. A review of the patterns of food production in the Pacific region, undertaken by the Asian Development Bank,[86] has revealed that the growth in agricultural production has slowed over the last four decades, and that it continues to do so across the region. Farming in the region remains mainly at small scale, depends on family labour, and focuses predominantly on meeting household subsistence needs. The small commercial agriculture sector in the region struggles to compete against food imports in domestic markets. The limited capacity of the smallholder agriculture sector to supply and satisfy the needs of the domestic market, at prices that are competitive with imports, is a significant factor that contributes to the increasing dependence on food imports of PICs, and increased incidence of poor household nutrition. Increasing the competitiveness of small farmers in their domestic markets is contingent upon greater investment in the adoption of productivity enhancing technologies and adapted plant varieties.

Adverse weather and pests and diseases result in more variable production, impacting the prices and availability of food commodities. Improving the productivity of the agriculture sector, through additional agricultural research into varieties best able to cope with climate variability and with increased pest and diseases, will be critical to reducing the cost of many of these local products on domestic markets. In addition, additional research and demonstration of off-season production technologies, and varieties, would help to reduce the variability in prices associated with seasonality. In addition, facilitating private sector investment into cost-effective irrigation and coverings to help farmers cope with variability in rainfall, are urgently needed in order to reduce the production risk facing farmers, especially smallholders

Given that the largest share of investment in primary production in the region is undertaken at farm level, facilitating an increase in agriculture production and processing efficiencies to a level that rivals food imports will depend on improving access to finance at interest rates that are competitive with those enjoyed by farmers in neighbouring regions. Accessing the capital to purchase inputs (improved planting materials, fertilizer, improved livestock breeds and feed), combined with the adoption of productivity-enhancing equipment (machinery, greenhouses, hydroponic and irrigation systems to prolong seasons and increase yields), is critical to maintain competitiveness in the agriculture sector.

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[86] ADB. 2011. *Food Security and Climate Change in the Pacific: Rethinking the Options*. Pacific Studies Series Manila: Asian Development Bank.

Access to these inputs, however, is constrained by the inability of many agriculture producers to obtain the long-term finance required to acquire such assets.

Increased investment in Fish Aggregating Devices (FADs) may help to improve catch rates and fish production among small scale fishing operators looking to sell to the domestic market. Similarly increased investment in aquaculture may help to reduce the cost of, and therefore access to, fish and seafood products produced for the local market. Lower prices would help to lift the share of fresh fish and seafood products in local diets, and help to reduce sodium intake associated with the consumption of canned fish products.

At present, loans to the agriculture sector in Samoa represent less than 1% of total commercial bank lending.[87] Ensuring cheaper access to finance for farmers and other value chain investors (agri-businesses and processing enterprises) will be a critical step towards attracting the investment in modernization necessary to improve the productivity, and competitiveness, of Samoa's F&V sector. With assistance from the World Banka and Asian Development Bank, Samoa has been able to offer matching grants and partial loan guarantees to small and large farmers and agribusinesses.

Partial loan guarantee schemes can help alleviate collateral deficiencies, which are one of the main reasons small and medium enterprises in the agriculture sector are unable to obtain credit. The schemes decrease the lending risk for financial institutions, through providing a loan repayment guarantee in the case of default and can thus play an important role in expanding access to funds for creditworthy agriculture enterprises. The loans should come at lower interest rates and require less restrictive collateral requirements because of the security of the guarantees. Credit guarantee schemes (CGS) can therefore be a useful policy tool to attract commercial financial intermediaries (e.g. commercial banks) to develop loan products and increase lending to prioritized sectors. National public and international funds are generally the major sources for guarantee funds. CGS are generally considered one of the most market-friendly types of credit intervention and a large number of countries around the world (including Fiji and Samoa) have made CGS a central part of their strategy to alleviate financing constraints.[88] However, ensuring the sustainability of Credit Guarantee Systems will require low loan default rates. In order to achieve this outcome, guarantors and lenders must properly screen and monitor potential clients, and select borrowers motivated to pay back the loans.

Matching grants provided to smallholder farmers to implement a specific development initiative (e.g. purchase farm machinery, invest in irrigation equipment etc.), under the agreement that the applicant will also contribute in money or kind, can also be affective at achieving good agricultural development outcomes. Matching grants are considered particularly suitable for financing capital investments (e.g. equipment). They provide a less market distortionary approach than artificially lowered interest rates

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[87] FAO (2015) *Food Matters: Policy Measures for strengthening food and nutrition security in the Pacific Islands*, FAO Sub-Regional Office for the Pacific: Apia

[88] Saadani Y, Arvai Z, Rocha R (2010) A review of credit guarantee schemes in the Middle East and North Africa, World Bank

because the subsidy is used to purchase goods and assets whilst any additional loan finance is obtained at market rates.

8. Conclusions

Improving the availability of nutritionally superior food products at lower unit costs is critical to improving food security, and health, in Samoa. This study finds that average (adult male equivalent) Samoan has access to 3509 Calories per day – slightly less than the average number of calories required to meet the average physical activity levels (high by international standards, given the large share of the population whose main activity is farming) and basal metabolic requirements (also high, given average reported weights) of a Samoan adult male: 3669 Calories. The study finds that the average Samoan has access to an insufficient amount of vitamin A and an excessive amount of sodium. The study also finds that given the levels of calorie intake, average fat intake falls below the safe upper limit for fat (established at 30% of total calorie consumption) and that average protein and iron intake levels meet the recommended daily minimum intake levels.

The gender of the household head was found to have a significant marginal effect on the capacity of members of the household to access to a diet satisfying all the nutrient intake thresholds, with members of female headed households found to have a slightly lower chance of accessing an adequate diet (or simultaneously satisfying all the nutrient intake thresholds). The level of income was shown as also have a significant effect on the capacity of households to access a diet satisfying all the nutrient thresholds, with households in lower (both bottom and middle) income terciles less likely to access the recommended intake levels, when compared to households in the top income tercile. Household head education was found to have a significant impact on household member access to a nutritious diet, with members of households where the head had completed primary education – or the first 8 years of schooling – and gone on to further study, being more likely to access a diet satisfying all the recommended nutrient intake levels.

An increase in the education level of the household head, beyond primary education was found to also have a significant marginal effect on reducing Calorie and sodium intake levels. The reduction in calorie intake is perhaps indicative of the changed employment profile (movement from farming to office work) and lower levels of physical activity associated with households where the head has obtained a higher level of education. The reduction in sodium intake among households where the head has obtained a higher education perhaps indicates that educated household heads are more aware of the impact of high sodium consumption on diet and health, and are selecting food items with a lower sodium content, or adding less salt at table or when preparing food.

An increase in the age of the household head was found to have a relatively small impact on the volume of household member nutrient intake for Calories, protein, fat, sodium and vitamin A. This result perhaps indicates the minor impact of the lower productivity of waged/farm labour committed by aged household heads on household income. Alternatively these results could be interpreted as reflecting a

voluntary preference for a lower rate of food intake among older household heads, perhaps reflecting a greater appreciation of the positive impact of moderation of food consumption.

A low level (bottom tercile) of income was a significant factor in five regression, with households in the bottom income tercile accessing a lower intake of fat, protein, sodium and vitamin A than households in the top income tercile. Households in the middle income tercile also accessed a lower intake of protein than households in the top income tercile. The reduced rate of protein intake among lower income groups is expected, given that more expensive meat products high in protein are less likely to feature as prominently the food baskets of members of these households as among higher income households. However the decreases in protein consumption among households in the bottom income tercile when compared to households in the top tercile were considerable. The lower rate of intake of sodium and fat when compared to the top income tercile is a positive outcome, given the high average intake levels reported earlier in this study. One can ascertain from this result, then, that high income does have a large marginal effect on sodium and fat intake, and that households in these income brackets should be targeted by policies aimed at reducing sodium and fat intake levels in the Samoan population. The reduced intake of vitamin A among low income households when compared to higher income households is a cause for concern, given the low average rate of access to vitamin A in the Samoan population revealed by this study. As a result, interventions to improve vitamin A intake in the general population could be augmented by a particular focus on low income households.

Members of households in the ‘rural’ regions of Savaii and ‘Rest of Upolu’ were found to have higher intake levels of calories and iron, than households in Apia. The higher calorie intake of members of households in these areas would be proportionate with the increase energy intake required as a result of higher levels of participation in farming and ‘manual labour.’ The increased iron intake is perhaps a consequence of both consuming a greater number of calories, as well as these rural households consuming a diet containing more root crops (such as own produced taro) high in iron. The increased intake of protein in the ‘Rest of Upolu’ is proportionate with the increased intake of calories, indicating that members of households in this region are not shifting towards a diet higher in protein, but are eating more food (perhaps as a result of higher levels of participation in farming). The decreased intake of fat among members of households in the NW Upolu peri-urban Region, when compared to Apia, is perhaps indicative of lower income and capacity to purchase a diet high in fat.

The mean share of income spent on gifts to church and other households is a large financial outlay, and this study found that the marginal effect of households spending more than the mean share of income on gifts was to reduce household member intake of calories, protein and sodium, when compared to households spending less than the mean share of income on gifts.

This study found that only 4 of the top 10 food items by share of total expenditure are locally produced, and just 11 of the top 30 food items (by share of expenditure) are locally produced. These results indicate that while imported processed food items are far more important as a share of household food expenditure than locally produced items, local foods – particularly taro – are integral to assisting households to meet the recommended minimum nutrient intake levels.

Taro (talo) represents the largest share of an average Samoan household's expenditure on food, and that it provides more than a third of the calories which an average household has access to; as well as a majority of household's iron intake and an important source of protein and vitamin. Rice is a far less important source of Calories in the average household food basket.

The study finds that after taro, purchases of meat products are most important in the household food expenditure basket, with expenditure on imported chicken pieces/quarters twice that of local fresh fish. Canned mackerel is the third most important source of protein and the most important source of vitamin A in household diet. Household expenditure on consumption of fruits and leafy vegetables was relatively low.

Table salt added for flavouring is by far the greatest source of sodium in household diets, at 41.1% of the total. Despite high levels of consumption of meat products, coconut (popo) is the major source of fat in Samoan household diets.

This study shows that the cost of a diet which meets the minimum food and nutrition needs of households – including their recommended calorie, protein, fat, sodium, vitamin A and iron intake, as well as providing their recommended intake of total dietary fibre, calcium, vitamin C and carbohydrates - is more expensive than the food poverty line (FPL) established for Samoa in 2015. This study found that purchasing an 'optimum food basket' would cost US$3.23 per person (Adult Male Equivalent) per day, whilst the FPL was determined to be US$2.17[89] per person per day. Therefore households whose level of income places them above the established national FPL may not have sufficient income to provide their family with an adequate diet.

The optimum food basket selected quantities of 6 food items identified as the most efficient for assisting Samoan households to obtain an adequate diet: taro, chicken pieces, pumpkin, bread and canned mackerel (eleni).

Given high levels of fat and sodium intake, this study recommends the introduction of a 20% excise on food items identified through nutrient profiling as 'unhealthy' in order to encourage substitution towards healthier products – given modelling done by the Samoan Ministry of Health indicates that this would have a positive impact on reducing sodium and fat intake. Working with manufacturers to reduce the sodium content of bread would also help to reduce household sodium intake. Similarly sourcing canned mackerel with lower sodium content would help to reduce sodium intake levels. Encouraging households to reduce the addition of table salt and sugar to meals and beverages, and switch to healthier types of cooking oil, would also significantly reduce calorie, fat and sodium intake levels. Fortifying flour products with micronutrients such as Vitamin A and Iron could help to increase intake levels of these important micronutrients..

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[89] UNDP (2015) *Samoa: A report on the estimation of basic needs poverty lines, and the incidence and characteristics of hardship and poverty – analysis of the 20013 Household Income and Expenditure Survey*, UNDP Pacific Centre and Samoan Bureau of Statistics, Suva

Improving access to these local food commodities by reducing their price to households identified as 'at risk' of poor nutrition through the policy and programme interventions outlined in this paper, will be critical to improving health and nutrition outcomes in Samoa. This study finds that reducing the price of local fruit, vegetable and animal products (particularly as pawpaw and chinese cabbage) identified as efficient sources of required vitamin A, would help to reduce the current deficiencies in daily intake among the Samoan population. Increasing consumption of these items at the expense of the current major sources of vitamin A in diet – particularly canned mackerel (eleni) would also help to reduce average sodium intake levels below the current high levels. This could be achieved through investments in improving the efficiency of production and marketing, supplemented by targeted food voucher schemes for at risk households and school feeding programmes. In addition, creating a more enabling environment to facilitate investment in improving the efficiency of local food production and distribution systems will be critical to reducing the cost of nutritious food for the wider Samoan population, in the long run.

Annex 1: The Pro's and Con's of using Household Income and Expenditure Surveys to estimate household nutrition outcomes

Food consumption data can be captured at the national, household, or individual level. According to nutritionists, the most accurate data on individual food consumption can be obtained through repeat 24-hour recall and observed weighed food record data collected through Nutritional Dietary Surveys (NDS). This information is usually collected in combination with anthropometric measurements (weight, height and waist), haemoglobin (Hb) levels, blood pressure, qualitative data on infant feeding of children less than 2 years of age, exercise, smoking, alcohol and other drug intakes of adults, in addition to food security and socio-economic information. However, because of the operational cost of undertaking blood sampling and measurements, it can be particularly challenging to implement these surveys regularly and reliably in low and middle-income settings, with the most recent survey conducted in the Pacific – Fiji, in 2004 – carried out on a sample of less than 1 per cent of the population.[90]

Demographic and Healthy Surveys have begun to be implemented in the Pacific more frequently, which include food recall (food consumed in the last 24-hours) questions, questions on child feeding practices and examinations of the nutritional status of children; and combines this with demographic, wealth and income information. 8 of these surveys have been conducted among the 14 PICs since 2007, and 5 more are planned between 2014 and 2017. These surveys do provide a good source of household and dietary information and combine with observation of nutritional impacts. However, the 24-hour recall method of establishing household diet and food intake practices has been subject to growing scrutiny due to the variability of the quality of the data that it can produce.[91] It has been identified that this method is more accurate when administered more than once for each participant, with best practice recommending between 3 and 7 times.[92] This variation can also be reduced by triangulation with other methods.

The WHO has begun to assist a number of PICs to adopt the 'stepwise' approach to NCD surveillance (STEPs); though implementation of STEPs can be challenging.[93] In addition, STEPS collects limited information on both household risk factors, such as diet, food expenditure and income, education levels,

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[90] Fiedler, J., Lividini, K., Bermudez, O., Smitz, M-F (2012) "Household Consumption and Expenditures Surveys (HCES): a primer for food and nutrition analysts in low- and middle-income countries." Food Nutrition Bulletin 33(Suppl 3):242–251

[91] Beaton, G., Milner, J., Corey, P., McGuire, V., Cousins, M., Stewart, E., de Ramos, M., Hewitt, D., Grambsch, P., Kassim, N., Little, J., (1979) "Sources of variance in 24-hour dietary recall data: Implications for nutrition study design and interpretation," *American Journal of Clinical Nutrition* 32(12):2546-2559

[92] Cupples, J., L. Cobb, E., Miller, D. and D'Agostino, R., (1992) "Comparison of Techniques for Estimating Nutrient Intake: The Framingham Study," *Epidemiology* 3(2):171-177

[93] Estimé, S. Lutz, B. Sobel, F. (2014) "Trade as a structural driver of dietary risk factors for noncommunicable diseases in the Pacific: an analysis of household income and expenditure survey data," *Globalization and Health*, 10:48

numbers of dependents, rural or urban location, and other factors identified as closely linked to food and income poverty in the Pacific[94]

National-level food data, such as FAO's Food Balance Sheets (FBS) and individual level food consumption data, can be useful sources of information for nutrition policy development. The Food Balance Sheet methodology for estimating national food availability depends upon multiple sources of information, including accurate production, trade, feed and seed, waste and other utilization. It provides information on food availability in quantities (tonnes), by commodity; and by kilograms per capita per year. In addition it provides information on food supply by kilocalories of energy, grams of fat and grams of protein, per capita per day.

However, there are a few challenges to using FBS data to estimate household consumption and diet, and the implications for health. The major challenge is that the paucity of agricultural production data, and data on the use of production to for feed and seed and waste, as well as other utilization, leads the FAO to depend on aggregate, standardized and 'calculated' data, rather than on official data.[95] Thus, the absence of official input data from countries in the Pacific is a major impediment to the accuracy of the dataset and its ability to track movements in food supply resulting from changed consumer preferences, rising food prices, natural disaster or pest and disease outbreak. Another challenge to using FBS data to examine household nutrition and risk factors is that the Food Balance Sheet dataset provides a single figure of per capita consumption derived from a national aggregate, obscuring distribution and therefore heterogeneity of consumption outcomes among households within countries. Finally, Food Balance Sheets do not report food supply outcomes for micronutrients critical to understanding the triple burden of malnutrition, including Vitamin and Iron; and other factors critical to understanding poor health outcomes, like sodium.

To help address the fundamental information gap, there have been a steadily growing number of studies using household food acquisition and consumption data from a variety of household food expenditure surveys, such as Household Income and Expenditure Surveys, as a proxy measure of household consumption.[96] Household Income and Expenditure Surveys (HIES) have been adopted by National Statistics Offices throughout the Pacific region over the last two decades, with multiple HIES having been conducted in most PICs. 16 HIES have been conducted in the PICs since 2006 with another 6 to be implemented between 2015 and 2018, which will provide 2 HIES datasets in each of Solomon Islands, Samoa, Samoa, Fiji, Tuvalu, Tonga, Palau, Kiribati, the Cook Islands, Papua New Guinea and Nauru. As a result, the HIES is the regularly implemented statistical census or survey currently implemented in the PICs.

HIES enable policy-makers to gain an insight into household calorie insufficiency, income and the percentage of expenditures on food (and other measures of vulnerability to food insecurity) and dietary

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[94] World Bank (2014) *Hardship and vulnerability in the Pacific Islands,* A regional companion to the World Development Report 2014, Washington, DC: World Bank

[95] A review of the FAO Food Balance Sheet for Samoa for the latest available year (2011) indicates that it is derived entirely using aggregate, calculated and standardized datas rather than official data

[96] Fiedler *et al.* (2012) *Op. Cit.*

diversity and quality, whilst also enabling calculation of food security outcomes within-country, at regional and household levels of food insecurity. In addition, because the food data are matched with various demographic characteristics of households they can be used to identify who the food insecure.[97] Finally, given that food insecurity manifests itself at household and individual levels, as the data on expenditures are collected directly from households themselves, they are likely to be more reliable than those derived from data collected at more aggregate levels.

Systematic, scientific sampling, usually approximating 10 per cent of all household, is the norm used in the PICs ensuring a nationally representative sample is surveyed through a HIES. The household sample frame used is provided by national population censuses. The most common method of data collection for HIES in developing countries is the personal interview, where an enumerator asks one or more household members to provide demographic and asset information, and recall income over a reference period, usually one month or twelve months. This is combined with the diary method for collecting household expenditure information. Using the diary method, households are asked to keep a detailed record of every expenditure item purchased or used by the household during the reference period. Through this method, data are collected on food acquired from three sources: (1) food purchases, including food purchased and consumed away from home; (2) food given to a household member as a gift or as payment for work; and (3) food that is home produced.[98]

The main criticism of HIES for the collection of food security and nutrition information is that data is collected at a household level and therefore estimates of individual consumption by converting to Adult Male Equivalents, may ignore differences in intra-household distribution of food resources.[99] Another criticism is that food expenditure data reflects the quantity of food *acquired* by a household rather than that *consumed* by its members, and that therefore some estimate of consumer waste or loss must be included in order to allow for some wastage or depreciation in the stock of food obtained by the household prior to consumption.[100] Based upon FAO Food Balance Sheet formula used to estimate loss in Samoa, losses account for 4.32 per cent of food stocks.[101] Another criticism is that the HIES method for collecting food consumption information is affected by reporting biases faced by all household surveys that employ interview methods, including recall errors, reporting errors, interviewer effects and "prestige errors" due to social pressures to inflate actual expenditure.[102] The periodicity of expenditures on different food items and the relative short length of the diary may lead households to either consume a product purchased prior to the diary period, or fail to record a semi-regular purchase which is a typical part of the household diet.[103] Finally, information on food purchased and consumed away from home is either underreported or reported in terms of food expenditures rather than food

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[97] Smith, L. (2007) Op. Cit
[98] Ibid
[99] Ibid
[100] Ibid
[101] Calculations using FAO Food Balance Sheets http://faostat.fao.org
[102] Deaton, A. and M. Grosh, (2000) "Consumption: Chapter 5," in Gosh, and P. Glewwe (eds) *Designing household survey questionnaires for developing countries: Lessons from 15 years of the Living Standards Measurement Study Vol.1*,Washington, DC: The World Bank.
[103] Smith (2007) *Op. Cit.*

quantities, which makes conversion to nutrition information difficult. Despite these challenges, estimates of food consumption patterns and apparent intakes of energy and nutrients obtained from national HIES are feasible and promising, when the challenges facing the alternatives are considered.[104]

[104] Fiedler *et. al.* (Op. Cit.)

Annex 2: Sampling method used for collecting Samoa HIES 2013 dataset

The HIES used a two-stage sampling method to select a representative sample of approximately 10 per cent of households to survey.

A household was defined as a group of persons (or a single person) who usually live together and have a common arrangement for food, such as using a common kitchen or a common food budget. The persons may be related to each other or may be non-relatives. Persons living in institutions, such as school dormitories, hospital wards, hostels and prisons were excluded from the survey, as were expatriate temporary residents and permanent residents who were not residing (and intending to reside) in Samoa for at least 12 months.

Each selected household was asked to complete a household questionnaire, responding to questions regarding household income activities and assets. Household income was considered to consist of all receipts whether monetary or in kind (goods and services) that are received by the household or by individual members of the household at annual or more frequent intervals. Household income therefore includes: (i) income from employment (both paid and self-employment); (ii) property income; (iii) income from the production of household goods and services for own consumption; and (iv) current transfers received (gifts received).

Each person in the household was asked to provide demographic information including age, sex, highest level of educational attainment and health status. Sample households were also asked to keep a diary of all household expenditure within a two week period. Household expenditure was considered to be the value of consumer goods and services acquired, used or paid for by a household through direct monetary purchases, purchases on credit, own-account production, barter or as income in-kind for the satisfaction of the needs and wants of its members. Household expenditure is therefore defined as the sum of household consumption expenditure and the non-consumption expenditures. The latter are those expenditures incurred by a household as transfer payments made to government, non-profit institutions and other households, without acquiring any goods or services in return for the satisfaction of the needs of its members, such as donations to charity.

It is possible to analyse all transactions recorded by the HIES according to the actual item being purchased or received (using the ‘item classification’) as well as the type of transaction used to acquire the good, service, income or other expenditure for which no good or service was obtained (called non-consumption expenditure). The type of transaction was classified according to cash purchase, own-account (subsistence) production, and gifts of goods received and gifts of goods given.

Annex 3: The methodology for using Household Income and Expenditure Surveys to estimate nutrition outcomes

National household surveys such as the Household Income and Expenditure Survey collect data on food acquisition or consumption from purchases in monetary and quantitative terms, and therefore report data collected at the food commodity by quantity, unit of measurement, and cost (in monetary value).[105] The process of converting this information into nutrition information requires a number of steps to be followed.

Matching Food Diary COICOP codes with food nutrient composition information

To calculate daily calorie and other dietary factors available to a household, the quantities of each food item are first converted to calorie and micro and macro nutrient values using conversion tables. The FAO has produced a series of regional Food Composition Tables providing nutritional information for various quantities of the food products most commonly eaten, including for in the Pacific region. Work undertaken on identifying the correct nutritional reference values for Pacific Island food products dates back to work undertaken in the 1940s and 50s by biochemists employed by the South Pacific Commission, and subsequently, by the Nutrition Department of the Fiji School of Medicine in the 1960's. This foundation work was subsequently improved upon throughout the 1980s and early 90's through subsequent pacific Island food composition programmes, funded by USAID and ACIAR. As a result, a comprehensive source of information of the composition of commonly eaten traditional foods, such root crops, and indigenous nuts, fruits and green leaves, was available when FAO resumed its interest in food composition work and development of regional food composition databases in the mid-90's, and was able to fill gaps in the Pacific Islands food composition tables. This subsequent work resulted in the production and dissemination of the second edition of the (2004) Pacific Island Food Composition Tables. This expressed the Calorie, micro and macronutrient quantity contained within each food product available in the Pacific Islands, per 100g serve. While the nutrient composition of fresh food items published in the Pacific Island Food Composition Tables is based upon the outcome of laboratory research, the macro and micronutrient contents of processed foods (i.e. canned beef and fish) is based upon average content; and therefore there is significant variation in the actual composition values for these food items both within and between PICs. Subsequently, there may be some variation in the household intakes levels where there is significant variation in contents of processed food items consumed within the sample population.

Calories are expressed in thousands of calories or kcal, while macro and micro-nutrients values are usually expressed as grams (g), milligrams (mg), or micrograms (μg) of nutrients per 100 grams. The calorie and other nutrition values provided for all the food products purchased are added and then divided by the number of days in the reference period, in order to obtain a daily household figure.

[105] Moltedo, A. Troubat, N. Lokshin, M. Zurab, S. (2014) *Analyzing Food Security Using Household data*, Washington D.C.: The World Bank

Standardization of the food quantities into grams or milliliters Equivalent

The unit of measurement of quantities used to record food expenditure in HIES household diaries can be either standard metric units - such as gram, kilogram, litre, or milliliter - or a local unit of quantity, such as bag, basket, cup, string or heap. Given all nutrient values are expressed in terms of nutrient content per 100 grams of the food product in the Food Composition Tables, local units need to be converted into metric units for ease of analysis. When the quantities collected are not standard metric weights and metric conversions are not easily known or recorded, metric units can be estimated using market retail prices to divide the value of expenditure by the upper market rate. However where households acquire food items for own consumption for products not commonly sold, they may be unaware of market values. Ensuring enumerators and households are informed of average market values and are trained to more accurately select metric units, will help to improve the accuracy of this method in the future.

Adjustment of food quantities for nonedible portions

Nonedible portions (e.g., bones, seeds, peels, etc.) are included in the reported food quantities but their proportion is not known to convert to edible portions (EP). While food quantities acquired include nonedible portions such as peels, bones, seeds, etc., nutrient values in the FCT are usually expressed per 100 grams EP. For this reason, there is the need to transform "as purchased" quantities into edible ones.[106] This transformation is done for each food commodity by applying the appropriate refuse factor. Some food commodities, such as rice, milk, or sugar, are 100% edible, but this is not the case for other food items such as bananas or manioc, have a significant refuse factor. The Edible Portion depends on the food product, and when it is expressed as a percentage varies from 1 (all edible) to 0.1.

FAO's *Food Composition Tables for International Use* and *Pacific Island Food Composition Tables* provides guidance on the edible portion of food items commonly consumed in the Pacific[107].

Using this source, we applied the following EP conversion factors to the dataset:

Figure 28: Edible Portion conversion factors

Food item	Edible Portion (% of AP volume)
kumala	83
cassava	75
yam	86
taro	82
chinese cabbage	79

[106] A resource guide for facilitating conversions, the *Guidelines for Converting Units, Denominators and Expressions* is available at http://www.fao.org/infoods/infoods/standards-guidelines/en/

[107] As purchased (A.P) to edible product (E.P) conversion rates from the above guides can be access at:
http://www.fao.org/docrep/x5557e/x5557e0l.htm#fruits
http://www.fao.org/docrep/x5557e/x5557e0k.htm#freshvegetables
http://www.fao.org/docrep/x5557e/x5557e0h.htm#starchesandstarchy
http://www.fao.org/docrep/x5557e/x5557e07.htm#pulses,nuts,andseeds

Taro leaves	69
carrots	92
pumpkin	68
ripe bananna	71
breadfruit	55
mangoes	62
watermelon	53
papaya	66
pineapple	64
coconut cream	15
peanuts	75
corn	38

Converting household consumption information into per capita information

When carrying out poverty measurement, an important consideration is if and how to account for the fact that the basic needs of young children are generally lower than those of adults.[108] The Adult Male Equivalent (AME) is an expression of household food intake that accounts for the composition of the household and allows the direct comparison of food or energy intakes of households with different numbers of members and different age and sex compositions. Adult males, age 18-60 years, are the benchmark for comparison, with younger and older males and females attributed a smaller or larger proportion of the AME (1). The AME shares attributed to each age and sex category vary for each nutrient factor and are calculated using the nutrient guidelines provided by FAO.[109]

In order to identify if households were consuming the RDI of various nutrients, for example, the study needed to calculate the total household-level RDI for each. This was done by summing the RDI of each individual of the household in the following way:

$RDI_{HH} = \sum_i RDI_i$; where *i* indexes members of a given household

In order to identify if households were consuming above the upper limit (UL) of fat and sodium, the study needed to calculate the total household-level upper limit of fat and sodium. This was done by summing the upper limit of each individual of the household in the following way:

$UpperLimit_{HH} = \sum_i UpperLimit_i$; where *i* indexes members of a given household

Using this information, it is possible to establish all the food items consumed by household members during the survey period, and calculate an average daily consumption figure for household members as a proportion of the Average Male Equivalent (AME). This information could be used to compare

[108] Haughton, H. and S. Khandker (2009) *Handbook on poverty and inequality*, Washington D.C: World Bank
[109] WHO and FAO (2002) Human Vitamin and Mineral Requirements, part of a joint FAO/WHO expert consultation, Bangkok: FAO

households with the required nutrient RDIs, ULs and ADERs for a healthy lifestyle, and to identify the characteristics of sub-populations of at risk households in order to better inform nutrition policy.

Calculating Average Dietary Energy Requirements

The average dietary energy requirement (ADER) of an individual is the level of energy intake from food that will balance energy expenditure - taking into account their level of physical activity, body size and composition, and long-term good health.[110]

The parameter used for adjusting the energy requirements is the average body weight of an individual in each age and sex category. Average weight is used in the Schofield equation method to calculate the Basal Metabolic Rate (BMR) for that age and sex category.[111] Using average weights to calculate energy requirements - where the average falls outside of the healthy range - has been subject to significant debate in the literature.[112] However in the absence of agreed guidance on the use of adjusted weights (or the rate of adjustment) in place of actual weights, this study uses the Schofield equation to calculate BMR. The Schofield equation for each age and sex category is provided below.

Table 20: Schofield equation for determining Basal Metabolic Rate requirements for each age and sex category

Age	Men	Women
0-6	59.512 × W - 30.4	58.317 x W - 31.1
7-11	59.512 × W - 30.4	58.317 x W - 31.1
1-3	59.512 × W - 30.4	58.317 x W - 31.1
4-6	22.706 × W + 504.3	20.315 X W + 485.9
7-9	22.706 × W + 504.3	20.315 X W + 485.9
10-18	22.706 × W + 504.3	13.384 X W + 692.6
18–30	15.057 × W+ 692.2	14.818 X W + 486.6
30–60	11.472 × W + 873.1	8.126 X W + 845.6
65+	11.711 × W + 587.7	9.082 X W + 658.5

The parameter used for adjusting the requirements due to the level of activity is the Physical Activity Level (PAL).[113] The PAL expresses a person's physical activity as a number is order to estimate the amount of food energy needed to maintain a particular lifestyle, above the basal metabolic rate (Table 21).

Table 21: Physical Activity Level (PAL) Scores for different occupations and lifestyles

Activity description	Subject description	PAL Score
1. At rest, exclusively sedentary or lying (chair-bound or bed-bound).	Old, infirm individuals. Unable to move around freely or earn a living	1.2

[110] Moltedo, *et al*. (2014) Op. Cit p.51
[111] Schofield WN (1985). "Predicting basal metabolic rate, new standards and review of previous work". *Hum Nutr Clin Nutr*. 39 Suppl 1: 5–41
[112] Woodruff, S. Hanning, R. and S. Barr (2009) "Energy recommendations for normal weight, overweight and obese children and adolescents: are different equations necessary?" *Obesity Reviews* 10(1):103-108
[113] Schofield (1985) *Op. Cit*

2. Exclusively sedentary activity/seated work with little or no strenuous leisure activity[a]	Office employees, precision mechanics	1.4–1.5
3. Sedentary activity/seated work with some requirement for occasional walking and standing but little or no strenuous leisure activity[a]	Laboratory assistants, drivers, students, assembly line workers	1.6–1.7
4. Predominantly standing or walking work[a]	Housewives, salespersons, waiters, mechanics, traders	1.8–1.9
5. Heavy occupational work or highly active leisure	Construction workers, farmers, forest workers, miners, high performance athletes	2.0–2.4

Source: Australian and New Zealand National Reference Values for Dietary Energy *http://www.nrv.gov.au/dietary-energy*

To calculate the ADER, we apply the PAL to the BMR for each age and sex category. In the absence of country specific information of the average physical activity levels engaged in by each age and sex category, we apply an average PAL score of 1.85 for adult male and females (the mid-point of the range for predominantly standing or walking work); and 1.65 for other age categories (predominantly sitting work, such as for students, etc). In the absence of country specific weight information, we use the average weights for each age and sex category, as supplied by the US Institute of Medicine, National Academies[114] and Kuczmarski *et al*. (2000), who derived them from the 50th percentile of the National Center for Health Statistics (NCHS) data. We subsequently applied the PAL multiplier to the BMR in order to find the ADER for each age and sex category. The results are displayed in Tables 22(for males) and 23 (for females) below.

Table 22: Male BMR and ADER by age category (weights derived from average weights (US) and PAL)

Men	**Schofield equation**	**Schofield eq. with weights**	**BMR (kcal)**	**ADER using PAL multiplier (1.85 adults; 1.65 all others)**
0-6	59.512 × W - 30.4	59.512 × 6 - 30.4	327	539
7-11	59.512 × W - 30.4	59.512 × 9.3 - 30.4	523	863
1-3	59.512 × W - 30.4	59.512 × 12.1 - 30.4	690	1138
4-6	22.706 × W + 504.3	22.706 × 18.4 + 504.3	922	1521
7-9	22.706 × W + 504.3	22.706 × 25.6 + 504.3	1086	1791
10-18	22.706 × W + 504.3	22.706 × 56.3 + 504.3	1783	2941
18–30	15.057 × W+ 692.2	15.057 × 65 + 692.2	1671	3091
30–60	11.472 × W + 873.1	11.472 × 65 + 873.1	1619	2995
65+	11.711 × W + 587.7	11.711 × 63.6 + 587.7	1333	2465
65kg Adult Male (18-65) energy requirement			1645	3043

[114] Institute of Medicine, National Academies Dietary Reference Intakes (2002): Recommended Dietary Allowances and Adequate Intakes, Vitamins Food and Nutrition Board.

Weights used are the following: 0-6 mo = 6 kg; 7-12 mo = 9.3 kg; 1-3 yr = 12.1 kg; 4-6 yr = 18.4 kg; 7-9 yr = 25.6 kg; 10-18 yr = 56.3 kg; 10-18 yr; 19-65 yr = 65 kg; 65+ = 63 kg as supplied by the US Institute of Medicine, National Academies[115]

Table 23: Female BMR and ADER by age category (weights derived from average weight (US) and PAL

Women	Schofield equation	Schofield eq. with weights	BMR (kcal)	ADER using PAL multiplier (1.85 adults; 1.65 all others)
0-6	58.317 x W - 31.1	58.317 x 6 - 31.1	319	526
7-11	58.317 x W - 31.1	58.317 x 9.3 - 31.1	511	844
1-3	58.317 x W - 31.1	58.317 x 12.1 - 31.1	675	1113
4-6	20.315 X W + 485.9	20.315 X 18.4 + 485.9	860	1418
7-9	20.315 X W + 485.9	20.315 X 25.6 + 485.9	1006	1660
10-18	13.384 X W + 692.6	13.384 X 52 + 692.6	1389	2291
18–30	14.818 X W + 486.6	14.818 × 55 + 486.6	1302	2408
30–60	8.126 X W + 845.6	8.126 × 55 + 845.6	1293	2133
65+	9.082 X W + 658.5	9.082 X 52 + 658.5	1131	2092
55kg Adult Female (18-65) energy requirement			1297	2400

Weights used are the following: 0-6 mo = 6 kg; 7-12 mo = 9.3 kg; 1-3 yr = 12.1 kg; 4-6 yr = 18.4 kg; 7-9 yr = 25.6 kg; 10-18 yr = 52.0 kg; 19-65 yr = 55 kg; 65+ = 52kg, as supplied by the US Institute of Medicine, National Academies[116]

Taking into account the BMR and PAL for each age and sex category, Table 24 presents a sample ADER. Note that no distinction is made for sex for ages below 10; and therefore the higher (male) ADER is used in these cases. Note also that the ADER for an active adult male with a weight derived from a healthy Body Mass Index (rather than the weight level for an average Samoan male) is 3040 kcal/day - significantly higher than the 2100/22200 kcal per capita per day per adult male commonly assumed in calculating the food poverty and income poverty lines used in household poverty reports in the Pacific (e.g. UNDP, 2012).

Table 24: The Average Daily Energy Requirement by age and sex category, based on 65kg Male and 55kg female

	0 – 6 months	7 – 11 months	1 – 3	4 - 6	7 - 9	Male 10 -18	Female 10- 18	Male 19-65	Male 65+	Female 19-65	Female 65+
Calories (kcal)	539	863	1138	1521	1791	2941	2291	3040	2465	2400	2092

Establishing an Adult Male Equivalent (AME) rate

The AME for each individual in the household is the ratio of that individual's recommended caloric intake to the caloric intake of an adult male. The AME is used to calculate the total AMEs in a household, which is a more appropriate measure of household size when analyzing nutrition. The sum of AMEs in a household is a standard unit of household size that gives different weights to individuals based on their

115 Ibid
116 Ibid

recommended daily intake. This means that a household consisting of 4 adult males will be considered to be larger than a household consisting of 4 infants.

The AME for a child, for example, is calculated as the following:

$$AME_{child} = \frac{ADER\ or\ RDI_{child}}{ADER\ or\ RDI_{Adult\ male}}$$

Table 7 below presents the AME for individuals by gender and age category.

Table 25: Calculating macro and micronutrient shares for age and sex categories on the basis of Adult Male Equivalents

	Infant		Young Child		Child	Adolescent		Adult			
						Female	Male	Female		Male	
	0-0.5	0.5-1	1-3	4-6	7-9	10-18	10-18	19-65	65+	19-65	65+
Vitamin A (ug/day)	375	400	400	450	500	600	600	600	600	500	600
Vitamin A AME	63%	67%	67%	75%	83%	100%	100%	100%	100%	83%	100%
Iron (mg/day)	0.2	11	9	9	10	11	14	8	8	18	8
Iron AME	3%	138%	113%	113%	125%	138%	175%	100%	100%	225%	100%
Sodium (mg/day) UL	1500	1500	1500	1900	1900	2200	2200	2300	2300	2300	2300
Sodium AME	65%	65%	65%	83%	83%	96%	96%	100%	100%	100%	100%
Protein (g/day)	11	17	14	19	22	51	40	92	62	78	52
Protein AME	12%	19%	16%	21%	24%	56%	44%	100%	67%	85%	57%
Total fat(g/day) UL	36	58	44	51	60	98	76	122	82	104	70
Fat AME UL	29%	47%	36%	41%	49%	80%	62%	100%	67%	85%	57%

The household AME for each nutrient or energy category is the sum of all AMEs of individuals within the household. It is calculated as:

$AME_{HH} = \sum_i AME_i$; where *i* indexes members of a given household

For example, the total Kcal AME for a household with 1 adult male aged 7-9 and 1 child would be:

$$AME_{HH} = AME_{Adult\ male} + AME_{child} = 1 + 0.49 = 1.49$$

Adult male equivalent intakes were calculated to standardize household consumption to intake per adult male equivalent. It does not utilize the richness of the RDI and UL standards, but it allows the study to benchmark using the standard AME. The AME intake for each nutrient is calculated as the total intake of the household divided by the total AMEs in the household.

For calories, it would be calculated in the following way:

$$AME_{Calories} = \frac{Caloric\ Intake_{HH}}{AME_{HH}}$$

Sample weights, attrition and error in measurement

All the estimates displayed in the tables were calculated making use of population weights provided by the SBS.

The initial household sample set selected by SBS consisted of 2792; however, complete questionnaires were submitted by only 2334. In order to improve the accuracy of the estimation, the study team constructed weights to mitigate attrition in the sample. The regression model also clustered the results at village level in order to control for inter-cluster correlations. In order to reduce the impact of food consumption outliers, households whose calorie intake (per AME) placed them in the top and bottom 1% of AME calorie distribution, were removed from the model. This further reduced the total number of households described in the following sections, from the original 2334 households, to 2286 – reduction of 2%. Thus, counting for sample attrition and after trimming the data to mitigate error in measurement in the quantity of food consumed, the sample reduced by 22%.

Attrition weights were constructed using the following formula:

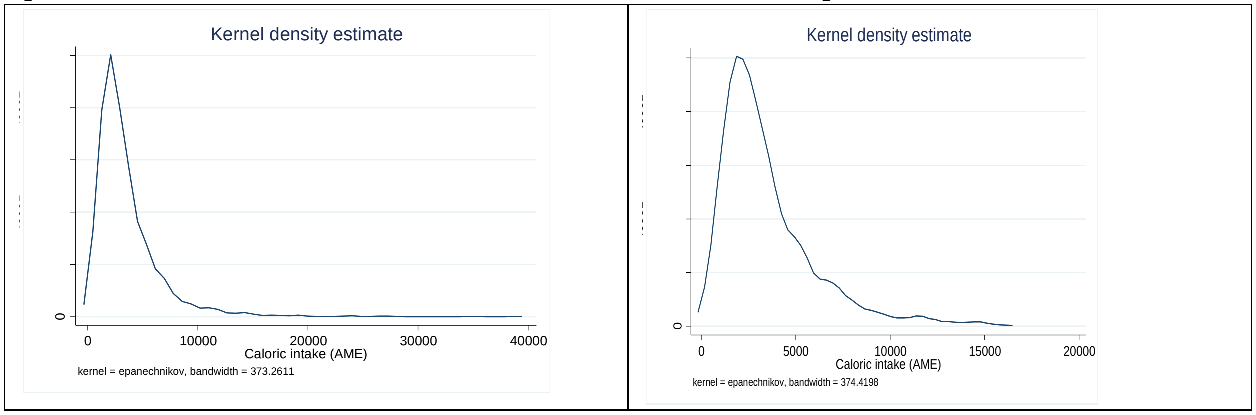
$$Attrition\ weights = \frac{N}{n}$$

In which "N" is the initial number of households selected to be sampled while "n" is the final number of households that were used in the analysis after counting for attrition and data trimming. In short, by making use of attrition weights calculated in such a way, EAs with greater levels of sample attrition would have relatively more importance compared to EAs where the attrition was lower. TableA. X displays overall initial and final sample size disaggregated by region while figure A.Y provide a description of the kernel density differences prior to and following this 'trimming' of the household set.

Table 26: Final sample set accounting for attrition and trimming

District	Initial sample	Final sample	Attrition_(%)
Apia	616	483	28
NW Upolu	916	754	21
Rest of Upolu	596	505	18
Savaii	664	544	22
Overall	2792	2286	22

Figure 29: Distribution of the AME calorie intake before and after trimming the data



Constructing independent variables

To conduct this analysis, the means for each of our nutrient intake indicators were calculated for each subsample of the data as it related to the following variables. The impact of the size of the household on nutrient intake levels was held constant in each regression, by calculating per capita (AME) nutrient intake values:

(1) Household head gender

The average nutrition and energy intake levels for both male and female headed households in presented in the descriptive tables. This factor is presented as a binary indicator in the regression analysis, with female headed households assigned a value of 1.

(2) Household head education

This variable is constructed using the total number of years of education obtained by the household head collected in the HIES survey and compiled by the statistics office.

Household heads were identified to have had access to Primary education or less is they had obtained 8 or less years of education. Household heads that have been identified to have obtained post-primary education are those that have had access to 9 or more years of education.

The average nutrient intake values for both post-primary educated and not household heads are presented in the descriptive tables, with the descriptive tables dividing the population of post-primary educated household heads into 3 categories: junior secondary, senior secondary and tertiary education. Household heads who have obtained a junior secondary education have had access to 9, 10 or 11 years of education. Household heads who have obtained a senior secondary education have had access to 12 or 13 years of education. Households who have obtained a tertiary level of education have obtained

more than 13 years of education. In the regression analysis, a binary variable is used with those household heads who have attained a post-primary level of education assigned a value of 1.

(3) Household head age

This variable is constructed using the total number of years of age obtained reported the household head collected in the HIES survey and compiled by the statistics office

The average nutrient intake values for differences in the age of the household head are reported in categories in the descriptive tables. In the descriptive tables, the mean nutrient intake values are reported for households whose head is aged 30 or less, 30-40 years, 40-50 years, 50-60 years and 60 years or older. In the regression analysis, a continuous variable is used with impact on nutrient intake of an additional year of age of the household head reported.

(4) Income tercile of household

This variable is constructed using the total household income data collected in the HIES survey and compiled by the statistics office. Total household income was calculated as the total value of subsistence production, agricultural sales as well as non-farm income such as wages, remittances and gifts. Home produced goods are valued at the local market price. This is done to standardize the unit of measurement for home produced goods. The market valuation of home produced goods is upward based and represents a ceiling value for these products.

This information is used as a binary variable in the regression analysis, but presented in the descriptive tables in terciles. In the regression analysis, this indicator examines the impact of low and medium income on the comparative household nutrient intake values of households in the top income tercile. Nutrient intake values of households in the bottom tercile (0-33rd percentile) and middle tercile (34th-66th percentile) are compared to the nutrient intake values enjoyed by those households' whose total level of income places them in the highest income tercile (67-100th percentile). A binary indicator is used the regression analysis to compare intake value for each 'lower income' tercile (Bottom tercile, Middle tercile) with households in the top income tercile in two independent variables. In the first 'Bottom tercile,' households in the bottom income tercile assigned a value of 1. In the second 'Middle tercile,' households in the middle income tercile are assigned a value of 1.

(5) Share of income expended on gifts is above the mean

This variable is constructed using the data collected in the HIES survey and compiled by the stats office on the value of household expenditure on donations to church, and gifts of goods and cash to other households, including contributions to wedding, funerals and other ceremonies. Total household income was calculated as the total value of subsistence production, agricultural sales as well as non-farm income such as wages, remittances and gifts. Home produced goods are valued at the local market price.

This information is used as a binary variable in the regression analysis, and is presented in the descriptive tables as a binary factor. In the regression analysis, this indicator examines the impact of a share of income expended on gifts which is above the mean share (16.8%). The nutrient intake values of

households whose share of expenditure is >16.8% are compared with the nutrient intake values enjoyed by those households' whose total level of expenditure on gifts is <16.8%.

(6) The Region in which households are located

This variable is constructed using the data collected in the HIES survey and compiled by the stats office on which of the 4 administrative regions they are located in: Apia, NW Upolu, Savaii and Rest of Upolu.

In the descriptive tables, the mean nutrient intake values for each Region are reported. In the regression analysis, a binary indicator is used in the regression analysis to compare intake value for each 'rural' Region (Savaii, NW Upolu and 'Rest of Upolu) with households in an urban location (Apia). This is completed through three different variables. In the first independent variable 'household in Savaii', households in Savaii assigned a value of 1. In the second independent variable 'household in NW Upolu,' households in NW Upolu are assigned a value of 1. In the third independent variable 'household in Rest of Upolu,' households in Rest of Upolu are assigned a value of 1.

Nutrient intake value maps

The mean nutrient intake value for each of the 43 districts for which information was available for, was used to illustrate mean intake values for each district, for each of the 6 macro and micro nutrients (calories, sodium, fat, protein, vitamin A and iron) as well as the share of households in the district whose diet 'satisfies all' the recommended nutrient intake levels, as one of five colour-coded intake levels: from 'low' to 'high.' Green is used to indicate 'low' intake for calories, fat and sodium; and 'red' is used to indicate 'low' intake for protein, iron, vitamin A and the share of households in the district whose diet 'satisfies all' the recommended nutrient intake levels.

Table 27: Nutrient intake thresholds used to indicate 'low' to 'high' mean intake (AME) per district in Maps

Low	caloric intake	fat intake	sodium intake	Low	protein intake	iron intake	Vitamin A intake	% households whose diet meets all nutrient recommendations
	<1900	<40	<500		<90	<8	<300	<10%
	1900-3200	40-65	501-1500		90-150	8-16	300-600	10-14%
	3200-4200	66-90	1501-2000		150-199	17-30	600-1500	14-19%
	4200-5500	91-120	2000-2300		199-270	31-45	1500-3000	20-22%
	5500+	>120	>2300		>270	>45	>3000	>22%

A list of the 43 districts who are represented in the maps is provided below.

01 Vaimauga East
02 Vaimauga West
03 Faleata East

04 Faleata West
05 Sagaga La Falefa
06 Sagaga Le Usoga
07 Safata
08 Siumu
09 Aana Alofi I
10 Aana Alofi II
11 Aana Alofi III
12 Falelatai & Samatau
13 Lefaga & Faleseela
14 Aiga I Le Tai
15 Falealili
16 Lotofaga
17 Lepa
18 Aleipata Itupa I Luga
19 Aleipata Itupa I Lalo
20 Anoamaa East
21 Anoamaa West
22 Vaa O Fonoti
23 Gagaemauga I
24 Gagaemauga II
30 Faasaleleaga I
31 Faasaleleaga II
32 Faaleleaga III
33 Faasaleleaga IV
34 Gagaemauga I
35 Gagaemauga II
36 Gagaemauga III
37 Gagaifomauga I
38 Gagaifomauga II
39 Gagaifomauga III
40 Vaisigano East
41 Vaisigano West
42 Falealupo
43 Alataua West
44 Salega
45 Palauli West
46 Palauli Le Falefa
47 Satupaitea
48 Palauli East

Multivariate regression analysis

This study uses the Ordinary Least Squares (OLS) method of multivariate regression analysis in order to find the marginal effect of the independent variables on the dependent variables.

The dependent variable in the analysis, nutritional outcomes (Y), is a set of dummy variables that indicate if a household is achieving the minimum recommended daily intake for a given nutrient (calories, protein, fat, sodium, iron, vitamin A).

Formally, the dependent variable is measured in the following way

(1) $y_{i1} = 1[Kcal_i < 3669]$
(2) $y_{i2} = 1[Protein_i < 92]$
(3) $y_{i4} = 1[Na_i > 2300$
(4) $y_{i5} = 1[Vit.A_i < 600]$
(5) $y_{i6} = 1[Fe_i < 8]$
(6) $y_{i7} = 1[Fat_i > 122]$
(7) $y_{i8} = 1[\sum_{k=1}^{8} y_{ik} < 1]$

Where:

i indexes households

k indexes nutrients

The study is interested in characterizing how household and community factors (X) are affecting nutritional outcomes (Y). Similar studies have modeled this demand to be a function of the following categories of variables[117]:

(A) Household head characteristics
  a. Gender
  b. Education
  c. Age
(B) Household characteristics
  a. Share of income expended on gifts
  b. Income tercile
(C) Regional variables
  a. Geographic regions
  b. Urbanization

The household characteristics, household head characteristics, and regional variables that are included in the analysis are:

(1) $\mathrm{x}_1 =$ Household head is female
(2) $\mathrm{x}_2 =$ Age of household head

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[117] Drescher, L. *et al.*, (2009) "Consumer Demand for Healthy Eating Considering Diversity – an Economic Approach for German Individuals," *International Journal of Consumer Studies* 33(6): 684–96.

(3) $x_3 =$ Education level of household head
(4) $x_4 =$ Share of income spent on gifts is above the mean
(5) $x_5 =$ Household is in the bottom tercile of total income, as compared top income tercile
(6) $x_6 =$ Household is in the middle tercile of total income, as compared top income tercile
(7) x_7 Household is located on Savaii, as compared to Apia region
(8) x_8 Household is located in NW Apia, as compared to Apia region
(9) x_9 Household is located in Rest of Upolu, as compared to Apia region

The relationship between X and Y is modeled using the following expression:

$$y_{ijk} = x_{ij}\beta_k + c_{jk} + \varepsilon_{ijk}$$

Where:

j indexes villages

y represents a nutritional outcomes

x is a vector of household characteristics

c represents an unobserved village effect

ε is a stochastic error term

Village level effects are included in the model for two reasons: first, the study is interested in characterizing the relationship between x and y while accounting for unobserved factors at the village level; and second, the study is interested in characterizing the relationship between nutrient intake values and urban areas, as well as with rural areas. Village level is the lowest level of aggregation that can be incorporated in the analysis.

Equations for each element of y (each nutrient) are estimated separately using correlated random effects OLS regressions. This regression technique allows model parameters to be estimated while conditioning out the effect of c by specifying the mean of c conditional on x, and a normal distribution of the error term.[118]

Food Rankings

This study calculated the total consumption of each food item within the surveyed sample, and ranked food items in a number of different ways.

The study produced the top 30 food by the following criteria (Rank each food *j*, by the sum of attribute over households, *i*)

(1) Highest expenditure: $\sum_{i=1}^{N} P_{ij} * q_{ij}$

[118] Wooldridge, J, (2010) *Econometric Analysis of Cross Section and Panel Data: Second Edition*, MIT Press, Boston.

(2) Highest consumed volume: $\sum_{i=1}^{N} q_{ij}$
(3) Largest source of calories: $\sum_{i=1}^{N} \mathrm{Kcal}_{ij}$
(4) Largest source of fat: $\sum_{i=1}^{N} \mathrm{Fat}_{ij}$
(5) Largest source of sodium: $\sum_{i=1}^{N} \mathrm{Na}_{ij}$
(6) Largest source of protein: $\sum_{i=1}^{N} \mathrm{Protein}_{ij}$
(7) Largest source of iron: $\sum_{i=1}^{N} \mathrm{Fe}_{ij}$
(8) Largest source of vitamin A: $\sum_{i=1}^{N} \mathrm{VitA}_{ij}$

The study then calculated the composition of diet of selected sub-populations characterized by share of expenditure, volume and nutrient intake by food groups. The study used the specific COICOP (Classification of Individual Consumption according to Purpose) codes assigned to each food item to categorise food and beverage selections for each sub-population into eleven categories which provides some insight into diet:

(1) Bread and cereals
(2) Meat
(3) Fish and seafood
(4) Milk, cheese and eggs
(5) Oils and fats
(6) Fruit
(7) Vegetables (ND)
(8) Sugar, jam, honey, chocolate and confectionery
(9) Condiments
(10) Coffee, tea and cocoa
(11) Mineral waters, soft drinks, fruit and vegetable juices

The share of total household nutrient intake (calories, sodium, fat, protein, vitamin A and iron) as well as share of expenditure and volume of food intake which is attributed to each of these eleven categories, is provided for the following sub-populations:

(1) All households
(2) Rural households (NW Upolu, Rest of Upolu, Savaii Regions)
(3) Urban households (Apia Region)
(4) Top income tercile households
(5) Bottom income tercile households
(6) Female headed households
(7) Male headed households
(8) Households headed by individual with a post-primary level of education
(9) Households headed by an individual without a post-primary level of education
(10) Households whose share of income spent on gifts is above the mean
(11) Households whose share of income spent on gifts is below the mean
(12) Households whose head is <30 years old
(13) Households whose head is >60 years old

This information is then presented in stacked bar graphs, and used to compare the mean shares of nutrient intake, expenditure and volume of consumption contributed by each food category type, among: rural with urban households; bottom income tercile with top income tercile households; female headed households with male headed households; households where the head is aged less than 30

years old with households where the head is aged more than 60 years; households headed by individual with a post-primary level of education with households headed by an individual without a post-primary level of education; households whose share of income spent on gifts is above the mean with households whose share of income spent on gifts is below the mean.

Optimum Food Basket

The optimization problem is then to minimize food expenditures by choosing a consumption bundle of food that meets all the nutrient intake requirements for a healthy diet. More formally, the optimization problem is expressed as the following:

(1) The objective is to minimize the cost of food
   a. $\sum P_i * q_i$
      where i indexes food items
      P represents price
      q represents quantity consumed

(2) Individuals must consume at least the recommended daily intake[119] for each nutrient explored in this study, in addition to the recommended intake values for some additional nutrients critical to a balanced diet (vitamin C, calcium, Total Dietary Fibre and Carbohydrates) without over-consuming fat or salt. The dietary constraints are expressed by the following expressions

   a. $3669 < \sum Kcal_i$
      ($Kcal_i$ represents the caloric content of food *i*)
   b. $> 92 \sum Protein_i * q_i < 184$
   c. $> 81 \sum Fat_i * q_i < 122$
   d. $\sum Na_i * q_i < 1610$
   e. $\sum Fe_i * q_i > 8$
   f. $> 600 \sum Vit\ A_i * q_i < 3000$
   g. $\sum Ca_i * q_i > or = 1000$
   h. $\sum TDF * q_i > or = 30$
   i. $\sum Vit. C * q_i > or = 45$
   j. $> 450 \sum Carbohydrates * q_i > 550$

When selecting the level of fat, carbohydrate and protein intake to be included in the final food basket, the model was programmed to preference the mid-point of the range.

(3) Individuals can choose from a set of food items (see Table 9)
   a. The choice set of food in this study is defined as the 50 most commonly consumed products in Samoa
   b. Individuals observe the price per 100g
   c. Individuals observe the nutrient content per 100g

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[119] World Health Organization, *Vitamin and Mineral Requirements in Human Nutrition* (World Health Organization, 2004).

The simplex algorithm implemented by the OpenSolver[120] application is used to solve the system. The solution to the programming task yielded the following results:

(1) q* - this is the optimum quantity of each food item the household should consume
(2) Minimum cost – this is the minimum expenditure possible to consume at least the daily recommended intake of each nutrient

The reader should heed the following precautions in interpreting linear programming results:

(1) The linearity of the objective function and constraints means that optimization will always yield corner solutions. A marginal change in a price could result in no change at all, or a complete shift to a substitute product. As a result, this method is limited in modeling smooth demand responses to price changes.
(2) This method assumes that the value of food is completely determined by its nutritional content. While this may represent a large proportion of the value of food, the model does not account for other potentially important non-nutritional aspects of food (taste, customs, perishability, etc.). The results should be interpreted as the theoretical behavior of an individual who only values the nutritional content of food and seeks to minimize cost.
(3) The prices used in the model are sample average prices. In reality, the prices that an individual faces in a certain location will not be the sample average of prices. For example, an urban consumer may face lower prices for rice and higher prices for farmed goods than a rural consumer.

[120] Andrew J. Mason, "OpenSolver - An Open Source Add-in to Solve Linear and Integer Progammes in Excel," in *Operations Research Proceedings 2011*, ed. Diethard Klatte, Hans-Jakob Lüthi, and Karl Schmedders, Operations Research Proceedings (Springer Berlin Heidelberg, 2012), 401–6, http://link.springer.com/chapter/10.1007/978-3-642-29210-1_64.

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