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Long-term trends in food availability, food prices, and obesity in Samoa

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Abstract

Objectives—To describe long term food availability and prices from 1961 to 2007 and BMI trends from 1980–2010 in Samoa, and to contextualize these trends within political, economic, cultural, behavioral, and climatic influences.

Methods—National level data on food availability and pricing were obtained from the open access database FAO (<http://faostat.fao.org>). Data for Samoa were collected from annual food balance sheets available for the period 1961 to 2007. Mean BMI for Samoan men and women ages 35–44 years of age is reported from four different time periods, 1979–82, 1991, 2003, and 2010.

Results—Total energy availability increased substantially, by 47%, with more than 900 extra calories available per capita per day in 2007 than in 1961. Many of these extra calories are supplied by dietary fat, the availability of which rose by a proportionally greater amount, 73%. Availability of both meat and vegetable oils rose substantially. Poultry meat increased the most proportionally, from 10 to 117 kcal per capita per day. Coconut products, fruit and starchy root crops – all locally grown – showed little to no increase over this time. As import prices for poultry and mutton increased their availability decreased, but the availability of vegetable oils rose despite a rise in their price. Mean BMI for men and women ages 35–44 years rose 18% rise from 1980–2010.

Conclusions—These long-term trends in food availability and prices, and the temporal pattern of BMI provide national level data for understanding the process of the nutrition transition in Samoa. Further work on consumer food prices, diet, food security and health is needed to further contextualize the transformation of the local food system in Samoa.

Keywords

food availability; FAO; BMI; Samoa

INTRODUCTION

The prevalence of obesity and related non-communicable diseases (NCDs) are well-established sources of mortality and disease burden in high income nations and have steadily increased throughout low and middle income nations (Drewnowski and Popkin, 1997; Mathers and Loncar, 2006). The nutrition transition has been implicated in the rising burden of NCDs in these nations although the changes in diet and physical activity levels which comprise the nutrition transition vary in rate and specific characteristics in different regions

and nations (Popkin, 2004). Some of the key characteristics of the dietary shift in low and middle income nations are increased consumption of animal fats and vegetable-origin oils and reduced consumption of complex carbohydrates, vegetables, and fruit (Popkin, 2004). A recent World Health Organization (WHO) global report on NCDs indicates that over the last several decades, low-middle income nations experienced a greater proportional increase in dietary energy supply available from fat, than both higher and lower-income countries (WHO, 2011).

Samoa, in the South Pacific, the study population for this report, is an example of a low-middle income country undergoing significant changes in dietary patterns and a steady rise in overweight, obesity, and NCDs (McGarvey and Baker, 1979; Baker et al., 1986; Keighley et al., 2007). Dietary intake studies in Samoa have illustrated the connection between changing nutritional choices at the individual level and rising obesity (Bindon, 1988, 2006; Malcolm, 1954; Galanis et al., 1999; DiBello et al., 2009).

The impact of these changing dietary behaviors are exacerbated by coincident lifestyle, occupational and food cost transitions which increase sedentary behaviors and introduce time constraints leading to greater consumption of convenient, cheap, energy-dense foods that are often high in salt, sugar, and fat (Drewnowski and Specter, 2004; Drewnowski et al., 2009). The complex relationships among food availability and prices, household budgets, national GDP, nutrient quality, dietary intakes and overweight, which have been described in detail by Drewnowski and colleagues in their discussion of the nutrition transition, highlight the need to measure and interpret dietary behaviors, from national level availability to more proximate consumption, in their fuller political and economic context.

Recent research has focused on how political and economic factors such as national, regional and global trade policies and tariffs transform domestic food supply systems, which in turn are related to changes in dietary patterns and increases in obesity (Hawkes et al., 2009; Thow et al., 2011a). For example, the introduction of transnational food processors, supermarkets, and global food advertising into developing countries increases both the availability and accessibility of highly processed food products, snacks, and soft drinks (Hawkes et al., 2009). Changes in Pacific Island nations' food trade policies have been implicated in the region's nutrition transition (Thow et al., 2011a). The competitive pricing of non-traditional Western staples may be stifling the production and consumption of local food products, as consumers have come to favor imported food products as symbols of societal status in Samoa (FAO/Fiti-Sinclair, 2004), and as these imported products become more available for consumption over time. This perspective was confirmed by Hughes and Lawrence (2005) who found that the "acceptance and/or belief that foreign goods and services are superior" led to "consumption of [imported] foods of low nutritional quality", and that this altered dietary pattern was correlated with adverse health outcomes in Pacific Island Countries. In addition, desire to achieve and maintain membership in global trade organizations such as the World Trade Organization (WTO) may lead small nations to maintain open national markets to other nations' exports, regardless of concerns about food quality and nutritional health issues (Hughes and Lawrence, 2005; Mitchell and Wallis, 2009). In fact, in late 2011, the Government of Samoa rescinded its import ban on turkey tails, which are known for their extremely high fat content, in order to facilitate entry into the WTO (http://www.wto.org/english/thewto_e/minist_e/min11_e/brief_samoa_e.htm).

The purpose of this report is to describe changing trends in national level food availability in Samoa from 1961 to 2007 using United Nations Food and Agriculture Organization (FAO) food balance sheets and to demonstrate their association with adult BMI levels from 1980–2010. The overarching aim of this report is to examine the local and global drivers of food availability and prices in order to provide a context for how the nutrition transition in Samoa

occurred. To contribute to progress in human population biology and health there is a need to combine our individual level measures of dietary intake and physical activity with analysis of structural political and economic influences on these nutritional behaviors, thereby elaborating models of the nutritional transition in our study populations. We are influenced in this report by prior work (Hawkes, 2010; Errington and Gewertz, 2010), which suggests that the increasing global production and trade of chicken, lamb, vegetable oil, and highly processed foods makes these items key in examining the dietary shift in developing countries. This report complements the parallel work of others' analysis of the FAO food availability database for Samoa in the context of food trade policies (Thow et al., 2011a). We became aware of Thow et al.'s (2011a) new contribution as we finalized this report and wish to point out the similarities in the description of temporal trends in food availability, but also the differences in our emphasis on BMI and food prices in a more behavioral interpretive context.

METHODS

National level data on food availability and pricing for Samoa were obtained from FAOSTAT (<http://faostat.fao.org> accessed 25 January 2011). This open access database, created by the FAO contains national level data on agricultural production, food supply, food security, and trade, including import and export value, for 183 individual countries.

Food availability data for Samoa were collected from annual food balance sheets available for the period 1961 to 2007. Food balance sheets present a comprehensive overview of a country's food supply within a specified time period, balancing food supply (local production, country wide stocks and imports) with utilization (exports, agricultural use and waste) to describe the availability of a commodity for human consumption (<http://faostat.fao.org>). The availability of each food item is described in the food balance sheet in both kilograms and kilocalories per capita per day, calculated by dividing the national availability of a certain food by an estimation of the country's population. Data are also presented which describe the contribution of protein (grams) and fat (grams) that each commodity makes to the food supply per capita, per day with summary data given for the total protein and fat supply available in grams per capita per day. This study utilizes the total food availability in kilocalories as well as the protein and fat supply in grams. Limitations to the use of the food balance sheets are discussed in the concluding paragraphs of this paper, but annual food balance sheets tabulated regularly as they have been in Samoa, are a reliable way of showing macro-level, national trends in food supply, dietary composition and the overall adequacy of food availability (FAO, 2010).

For each commodity, data on the quantity and value of yearly imports and exports are available in the FAO TradeStat data sheets¹. This study utilizes import value and quantity to yield an estimate of import price. Total import value is rounded to the closest 1000 US dollars and import quantity is given in metric tons; dividing the total import value for a particular year by total import quantity for the same year yields import price in \$1000/metric ton.

The BMI data derive from community studies in Samoa conducted at four times between the late 1970s and 2010; specifically 1979–82, presented graphically as 1980; 1991; 2003 (Keighley et al., 2007), and 2010 (McGarvey, unpublished data), using the same basic anthropometric techniques for stature and body weight. Although our presentation of BMI

¹At the time of original access, data on import quantity and value were found in the Food Supply portion of the FAOstat website. Since then, changes to the website mean that these data are now located in the TradeStat database. For reproducibility their current location is described above.

data is limited to the period 1980–2010, we chose to present all accessible food availability data (1961–2007) because data from these earlier years helps to contextualize influences on dietary changes and health responses in later decades. In (Western) Samoa in 1979 and 1982 field teams and individual PhD students from the Pennsylvania State University Samoan Studies Project worked in two rural Upolu villages, and in addition chose adults in the wage labor force in the capital Apia who derived from villages within commuting distance (Baker et al 1986). In Samoa in 1991 adults 25–54 years of age were randomly chosen from nine villages, including four from rural Savai'i, three from rural Upolu and two from the urban Apia area, in order to represent the national distribution (Chin-Hong and McGarvey 1996). In 2003, adults 21–79 years of age were selected for a genetic epidemiology study throughout all rural, peri-urban and urban census regions of Samoa (Dai et al 2008). Recruitment was first based on finding individuals in Samoa who were members of American Samoa pedigrees who had been recruited in 2002. We then selected samples from 55 villages throughout Samoa to assess geographic and economic diversity, and chose families based on availability of large families with probands not selected for obesity or type 2 diabetes (Dai et al 2008). Later comparisons to census data showed no differences in key socio-demographic factors between those selected for inclusion and the general population. In 2010 adults 25–65 years of age were sampled from 33 villages from all census regions as part of a genome-wide association study. The sample was very similar to the 2006 census data for key socio-demographic variables (McGarvey unpublished data). Clearly none of these samples are from probability-drawn nationally representative surveys, however the later three, 1991, 2003 and 2010 are very similar to national census data.

For each of these four samples we chose male and female adults aged 35–44 years to describe temporal trends in BMI from 1980–2010. We chose this age group since all four samples contained adults of these ages, had good sized samples, this age reflected the impact of younger adulthood ways of life, and had exposure to the diets structured by the food availability period under study. These temporal BMI trends in those 35–44 years are very similar to the two other adult 10-year age groups for which we had BMI data at all four times: 25–34 and 45–54 yrs (Keighley et al 2007, McGarvey unpublished data). The sample sizes for this age group by year and sex are as follows: 1980, male $n=36$ and female $n=45$; 1991, male $n=108$ and female $n=118$; 2003, male $n=105$ and female $n=105$; 2010, male $n=322$ and female $n=566$.

RESULTS

Figure 1 presents total energy and fat availability in kcal/capita/day in Samoa between 1961 and 2007 with the BMI data from 1980 to 2010. At the population level, total energy availability has increased substantially over the last five decades, from 1960 kcal per capita per day in 1961 to 2886 kcal per capita per day in 2007, an extra 926 kcal per day, a 47% increase. Proportionally, the increase in total fat availability was even greater, rising 73% from 81 grams per capita per day in 1961 to 139 grams per capita per day in 2007.

BMI among 35–44 year old men and women increased by almost 18% from 1980–2010 (Figure 1). Specifically by sex, male mean BMI in this age group increased by 17.8%, from 26.5 kg/m² in 1980 to 31.21 kg/m² in 2010 while female BMI increased by 17.6% from 29.7 kg/m² in 1980 to 34.93 kg/m² in 2010. For both males and females this represents a transition of mean BMI in the overweight category by WHO standards (25–30 kg/m²) to the obese category (>30 kg/m²).

Figure 2 shows the caloric availability of meat products and vegetable-based oils. Availability of both meat and vegetable oils has risen substantially since the first recorded data in 1961. Poultry meat has shown the greatest percentage increase in availability over

this 46-year time period. In 1961, the availability of poultry meat was approximately 10 kcal per capita per day, but in 2007, availability had risen to 117 kcal per capita per day, representing a more than ten-fold increase.

Pork was the greatest source of meat calories in the Samoan diet in 1961 and remained so in 2007 with availability increasing by approximately 154% over this period, from 85 kcal per capita per day in 1961 to 217 kcal per capita per day in 2007. The greatest increase in pork availability took place between 1979 and 1990 increasing by 192% in 11 years to a peak of 239 kcal per capita per day in 1990. Mutton availability also increased overall, rising rapidly by 189% from 62 kcal per capita per day in 1980 to 181 kcal in 2001. By 2007, however, caloric availability of mutton had declined, dropping to 95 kcal per capita per day; a 48% decrease from 2001. Caloric availability of vegetable oil increased by 66% between 1961 and 2007, from 128 kcal per capita per day in 1961 to 214 kcal per capita per day in 2007.

While continuing to contribute a large proportion of the caloric availability in the Samoan diet compared to other foods, coconuts and coconut products, fruit and starchy root crops, which are all locally produced, have shown relatively little, if any, increase in dietary availability over time (Figure 3). From 1961 to 2007, calories available from coconuts rose from 439 kcal per capita per day to 528 kcal, representing a 20.3% increase in availability.

Similarly, the availability of fruits has risen very little. Following an increase in availability during the 1960s, the caloric contribution of fruit remained relatively constant at around 290 kcal per capita per day until the early 1990's at which point availability decreased by more than 75% to just 62 kcal per capita per day. This time period is associated with significant damage to island crops by three natural disasters: Cyclone Ofa (1990), Cyclone Valerie (1991), and the Taro Leaf Blight (1993), which are included in Figure 3. Availability of fruits has recovered since the mid-1990s but has not returned to the levels experienced between 1970 and 1990.

Starchy root crops experienced a similar decline during the natural disasters of the early 1990s. From 1989 to 1995, the dietary availability of starchy root crops decreased 78%, falling to 100 kcal per capita per day. During the same years, the availability of imported rice increased substantially, compensating for the 372 kcal per capita per day decline in starchy roots with an increase of 338 kcal per capita per day, a more than two-fold increase in less than 10 years (data not shown). From 1995 to 2007, starchy root availability rose again to a level of 286 kcal per capita per day, far from the levels of the late 1980s which exceeded 365 kcal per capita per day, while rice availability declined to close to pre-cyclone levels.

Figure 4 shows changes over time in each key food as a proportion of the total dietary fat supply which rose over time (see Figure 1). Although by far Samoa's largest agricultural export, coconuts (and copra) have consistently made the greatest contribution to the dietary fat supply. The proportion of total dietary fat supplied by coconuts has fallen however, from a peak of 59% in 1975 to 33% in 2007. These results indicate the supplementation of traditional fats in the national diet with processed animal fats and vegetable oils, many of which are imported. The proportion of dietary fat supplied by vegetable oils has shown the greatest increase, a more than three-fold increase since the 1980s. The contribution of poultry as a proportion of the dietary fat supply has also increased from less than 1% of the total fat supply in 1975 to more than 5% in 2007. Both mutton and pork made lesser contributions to dietary fat in 2007 than they did in the 1980s and early 1990s.

Figures 5A–C present the caloric availability and import price of three key items: vegetable oil, poultry, and mutton. The data for both poultry and mutton support the fact that when the cost of imports is greater, the availability of the food is less. When poultry reached its peak

import price of more than \$1900 per metric ton in 1996, availability fell to its lowest level in ten years. From 1996 to 2007, poultry meat saw a 54% decrease in import price to \$897 per ton, and availability rose accordingly. As the price of poultry was falling in recent years the price of mutton was increasing, rising 72% over the same time period, accompanied by a decline in availability of 33%. In contrast, the availability of vegetable oil rose despite an increase in price of 72% from \$806 per ton in 1976 to \$1385 in 2007.

DISCUSSION

Since the 1960s the availability of total energy in the Samoan food system has increased substantially, by 47%, with more than 900 extra calories available per capita in 2007 than in 1961. Many of these extra calories were supplied by dietary fat, the availability of which rose by a proportionally greater amount, 73% between 1961 and 2007. The increase in food availability over this period coincided with an 18% rise, from 1980–2010, in mean BMI for men and women 35–44 years of age. This time period was also characterized by general economic and social modernization, educational improvements, increased ownership of consumer durables and technology, and changes in the occupational status of many from subsistence agriculture to sedentary work (W Samoa, 1983; W Samoa, 1995; Samoa, 2000; Samoa, 2008). During this time, gross domestic product per capita rose from \$282 in 1970 to \$723 in 1980, to \$694 in 1990, to \$1308 in 2000, and to \$2926 in 2009 (United Nations Statistics Division, 2011). This large increase reflects the country's transition to a cash economy, and is consistent with reports of increased dietary consumption of purchased and imported foods. The impact of these non-food elements of modernization on obesity status have been previously discussed (Baker et al., 1986; Galanis et al., 1999; Keighley et al., 2006). This study focused on the role of changing food availability in rising obesity and took cues from the work of Ulijaszek (2002, 2003), Hawkes (2010) and Errington and Gewertz (2010) in examining the evidence for a nutritional transition in Samoa.

Our national-level findings on the caloric availability of key foods in Samoa are consistent with previous individual-level dietary intake studies conducted in the Samoan archipelago (Bindon, 1988, 2006; Malcolm, 1954; Galanis et al., 1999; DiBello et al., 2009), and suggest that while the FAO data does not provide evidence about consumption it may be a reasonable proxy for changing dietary intake. As early as 1952, urban Samoans and American Samoans were moving away from a subsistence agriculture way of life toward wage labor systems and imported food consumption (Malcolm, 1954; Bindon, 2006). Malcolm (1954), in describing the traditional diet in (Western) Samoa, highlighted taro, yams, coconut, bananas, and breadfruit as the major dietary staples. Studies in the 1970s through the mid-1990s described the increasing consumption of canned corned beef and fish, pork, chicken, rice, and white bread in both Samoa and American Samoa (Bindon, 1982; Galanis et al., 1999). More recent work in Samoa indicates that the modern dietary pattern is characterized by high intakes of sausage, eggs, rice, instant noodle soup, pancakes, cereal, cake, potato chips, chop suey, rice dishes, and low intakes of coconut cream dishes and taro (DiBello et al 2009).

These food availability trends also show for one specific nation in the Pacific the general patterns of the nutrition transition and fat availability in other developing nations (Popkin, 2004; WHO, 2011). Generally, the theory of the nutrition transition contends that the modernization and 'westernization' of the diet in low- and middle-income countries involves increased consumption of fat both from animal sources and vegetable oils, and a decline in the contribution of local 'traditional' commodities to daily dietary intake (Drewnowski and Popkin, 1997). These changes have been reported globally, as low-middle income countries in general have experienced more rapid increases in fat availability than other countries (WHO, 2011). Support for Samoa's experience of the nutrition transition can be seen in the

marked rise in the caloric availability of poultry, mutton, pork and vegetable oils and the decline in complex carbohydrates such as fruit and starchy root crops.

Globalization and Samoa's Food System

While the majority of pork has remained domestically produced (Saville and Manuelli, 2002), the increased availability of fat from poultry, mutton and vegetable oil sources can be linked largely to the globalization of food production and trade and changes in local legislation. Vegetable oils, in particular, have received attention in both academic and political literature in recent years as their export to developing countries continues to rise. In the early 1990s, soya bean oil exporters Argentina and Brazil and palm oil exporters Indonesia and Malaysia implemented policy changes that encouraged foreign investment in oil crop processing, shifting their focus from the production of oil for domestic consumption to production for export (Hawkes, 2010). As a result, both of these vegetable oils are produced in extremely large volumes, with palm oil recently overtaking soya bean oil as the cheapest commodity vegetable oil to produce, refine, and purchase on the global market (Carter et al., 2007). Global consumption of palm oil has risen substantially because of the oil's availability and relatively low cost, and this increased consumption has been cited as an important contributor to the increasing dietary fat intake in the developing world (Hawkes, 2006; Popkin, 2004). The FAO data for Samoa does not currently distinguish between different types of vegetable oils, but a small study in Samoa in 2010 documented palm oil produced in Indonesia as being the most commonly available type of vegetable oil, both in supermarkets and small family-owned stores (McGarvey, unpublished data). It is likely that the increased global trade of palm oil has contributed to the increased availability of vegetable oils in the Samoan diet which at 214 kcal per capita per day in 2007 is similar to other developing countries reported by Hawkes (2010) as 239.1 kcal per capita per day in 2003.

In 2007, 6022 tons of chicken meat was imported into Samoa at an import value of more than 5 million US dollars (FAO, 2011). With no onward export or agricultural use that meat would have been made available in the food supply and contributed to the rising trend in caloric availability from this food source. The vast majority of that meat was imported from the USA, which accounted for approximately 5970 tons of the import quantity (FAO, 2011). Hawkes (2010) has previously described a massive increase in US exports, particularly the fatty, dark meat, leg-quarters of chickens, to low- and middle-income countries, which has been facilitated by advances in processing (freezing and mechanical de-boning). The association between availability and price is particularly striking for poultry imports in Samoa (Figure 5B), with availability rising as import price has continued to fall steadily since the mid-1990s.

The availability of turkey tails remains a key issue due to its low nutritional value as well as for the implications of changes in global politics and food importation. Turkey tail imports were banned in Samoa only from 2007, when the currently compiled FAO data ends, to 2011, when the ban was removed as part of Samoa's bid to join the WTO. The contribution of turkey tails and related high-fat low price poultry products to Samoa's food supply should be monitored, and levels of consumption evaluated.

Hawkes et al. (2009) characterized the nutrition transition not necessarily as a complete substitution of domestic fat sources by imports, but instead as an addition or supplementation of imported foods to existing sources of dietary fat. Further evidence for the supplementation of traditional foods in the Samoan food system can be seen in the proportional increases of vegetable oil, and poultry to the total fat supply (Figure 4). The relative contribution of coconuts as a source of available fat has been slowly declining as availability of fat from other sources, both domestic and imported, has increased.

Domestic Legislation and Local Food Systems

Legislation passed in Samoa, and elsewhere in the Pacific, may also have affected the Samoan food supply; this is particularly apparent with poultry, mutton and pork imports. Prior to 1976, an order prohibiting the importation of birds and poultry products was in place and its revocation was likely the prompt for the rise in availability of poultry described in figure two. Similarly, an order prohibiting the import of pig and pork products was imposed in 1977, preceding a tripling in domestic pork production as breeding for local consumption increased. Pork traditionally made the greatest contribution to caloric availability from meat products and this domestic source remained the greatest contributor in 2007 (Figure 2). While not banned in Samoa itself, mutton flaps—a fatty cut of sheep meat consumed in many Pacific island nations—were banned in Fiji in 2000 with the government citing the food's negative impact on the health of the population as a justification for the ban (Clarke and McKenzie, 2007; Errington and Gewertz, 2010). The highly publicized nature of this decision and the consequent criticism of New Zealand's role in exporting these unhealthy 'waste' products (Errington and Gewertz, 2007; Thow et al., 2010; Wyber et al., 2009) may have influenced demand in Samoa as mutton imports fell markedly after 2001. The steep increase in the import price of mutton meat following this legislation is also a likely contributor to the decline in availability.

Implications of Nutrition Transition for Non-Communicable Disease

The temporal coincidence between increases in adult BMI from 1980–2010 and increases in availability of total energy and fat over the 1961–2007 time period in Samoa are consistent with the extremely well-documented temporal changes in NCDs and risk factors including obesity, hypertension, type 2 diabetes and blood lipid levels in Samoa and American Samoa (Baker et al., 1986; McGarvey et al., 1993; Collins et al., 1994; Hodge et al., 1994; Hodge et al., 1997; Hughes and Lawrence, 2005; Keighley et al., 2007) and in other Pacific nations such as Tonga (Evans et al., 2001). For example from 1978 to 1991 in three regions of Samoa, age-standardized adult obesity prevalence (BMI > 30 kg/m²) increased sharply, especially in one rural area where the change was from about 12% to 36% among men and from 26% to 57% among women (Hodge et al., 1994). The same research group also reported dramatic increases in type 2 diabetes levels based on glucose tolerance tests in the three regions and for the nation of Samoa from 1978 to 1991 (Collins et al., 1994). Likewise, our own studies in Samoa show that from 1991 to 2003 type 2 diabetes prevalence (fasting serum glucose > 126 mg/dl or use of diabetic medications) in those 35–44 years of age increased from 1.9% to 2.1% in men and from 2.1% to 3% in women (Keighley et al., 2007). By 2010 type 2 diabetes, as assessed in 1991 and 2003, was found in 7.8% of men and 10.3% of women 35–44 years of age. Hypertension prevalence also rose from 1980 to 2003 in 35–44 year old men and women, 10% to 24%, and 11% to 20%, respectively (Keighley et al., 2007).

Dietary patterns contribute heavily to the rise in prevalence of NCDs worldwide and in low and middle income countries (WHO 2011). Frequent consumption of energy-dense foods that are high in fats and sugars promotes obesity compared to consumption of low-energy foods such as fruits and vegetables. Consumption of dietary salt is an important determinant of blood pressure levels and cardiovascular risk. There is also evidence that the risk of type 2 diabetes is directly associated with consumption of saturated fats and trans-fats but inversely associated with polyunsaturated fats, which derive mainly from vegetable sources (WHO, 2011).

Climatic Influence on Food Availability

While globalization and the supplementation of traditional foods in the diet can be held responsible for some of the shifting dietary patterns in Samoa, it is clear that regional

climatic events exacerbated the decline in availability of local fruits and starchy root crops. Cyclone Ofa in 1990 and Cyclone Valerie in 1991 coincided with a marked decline in the caloric availability of fruits and starchy roots (Figure 3) reflecting the impact of the tropical storms. Ofa lasted more than two days with wind gusts of up to 97 knots causing extensive damage to plantations on both Samoan islands, Upolu and Savaii, with wind damage to tree crops and saltwater poisoning of trees and crops at the ground level (SOPAC, 1990). This was quickly followed by Valerie in late 1991 with its wind gusts of up to 130 knots (UNDRO, 1991) inflicting further damage. While tree crops, largely fruits, began to recover as early as 1992/1993, starchy root crops were further reduced by the 1993 taro leaf blight. Taro is the most widely farmed root crop in Samoa; a nutritionally valuable staple of economic, cultural and ceremonial importance (Hunter et al., 1998). Taro leaf blight, a pathogenic crop disease which can result in huge reductions in yield was first discovered in Samoa in early 1993 and within a year of its introduction it had caused over a 95% reduction in the supply of taro to the public market (Hunter et al., 1998), far greater than the estimated 50% reduction in yield seen in other occurrences of the disease (Trujillo and Aragaki, 1964; Jackson, 1977). The rapid spread of the disease in Samoa can be linked directly to the preceding cyclones, as large scale replanting of taro crops in the aftermath of Cyclone Valerie—nearly 10,000 plants per week—accelerated the geographic spread of the disease (Semisi, 1993).

Global Aid Responses Exacerbate Dietary Shifts

As we noted in the results, rice imports rose substantially as the availability of starchy root crops declined in the early 1990s. Food aid programs coordinated by the National Disaster Council and the Samoan Red Cross after the two tropical cyclones consisted mainly of rice and flour supplements, and our prior work showed that during this time period, consumption of rice and pancakes more than doubled, while the caloric contribution of these items to the daily diet nearly tripled (Galanis et al., 1995). We argued that food aid in the context of Samoa may have accelerated the existing dietary transition toward imported sources of carbohydrates and fat (Galanis et al., 1995). In recent work, Thow et al. (2011a) described a slow increase in cereals (including rice) availability before the natural events, a rapid increase after the two cyclones and the taro blight, followed by a sustained elevation in their availability. Our results for rice availability indicate that it rose more slowly early in the period, rose dramatically after the storms and then declined in the period 1999 – 2007. We chose to highlight rice availability because it showed the largest changes of the cereal types in the whole period, and it appeared to compensate in calories for the loss of root crops.

Whether or not the decline in fruit and starchy root availability would have occurred without the destructive nature of the natural disasters cannot be determined, however data from other Pacific Island nations collated by the WHO (2003) support a general decline in the availability of fruits, vegetables and starchy root crops over the same time period. The ability of the FAO food balance sheets, constructed at the population level, to reflect changes in the food supply after such events does, however, speak to the validity of this data source.

Limitations

There are several limitations to the use of population-level data collected in this manner. Food Balance Sheets are constructed using data from a variety of sources including estimates produced by trading partners and the resulting data are only as accurate as the reporting. There are limitations in the calculation of both supply and utilization which should be taken into account in the interpretation of these data. An example is that total fat supply in Samoa reported by the FAO is likely an underestimate of actual fat availability in the diet since it is based only on the list of food items reported in the food balance sheets.

According to the FAO methodology, local production, as it contributes to the food supply, is usually recorded at the end of a “main harvest period.” It is important, however, to note that there may be substantial secondary harvests later in the year that remain unaccounted for in the current model (FAO, 2010). Regardless of the timing of data collection, however, having methodologically consistent data collection over a long period of time such as that recorded by the FAO, helps to reveal major trends in food availability.

Imports are extremely important in the context of nutritional transition which is the focus of this descriptive analysis, but are only recorded on a government level with no estimate of the contribution of informal imports to the available food supply. Utilization is expressed at the per capita level, calculated by dividing availability by a current estimate of population size. Using these data, it was impossible to estimate food availability levels across age, gender, and socio-economic groups—all of which are important considerations when considering nutritional transitions.

Another major limitation when discussing evidence for a nutritional transition is the lack of reporting on snack foods—soda, candy, chips, and other convenience foods—which have been consistently implicated in rising obesity worldwide (Hawkes, 2010; Brownell et al., 2009; Thow et al., 2011b). Certainly in Samoa the increased consumption of non-local staple foods has been documented (Bindon, 1988; Galanis et al., 1999; Keighley et al., 2007; DiBello et al., 2009). For example, a temporal comparison from the 1990s to 2002–03 showed a marked increase in consumption of soda beverages, potato chips and other fast or snack foods, as well as greater consumption of these foods by children relative to adults (Keighley et al., 2007). Links between imported fatty and processed foods and other aspects of the modern diet to obesity and metabolic disorders have also been found (DiBello et al., 2009).

Despite the limitations of the food balance sheet data, timely and reliable population-level statistical information of this kind has great importance for the formulation of sound development plans and policy aimed at improving the efficiency of production of local commodities and the distribution of food and agricultural products. The ability of these data to depict national level shifts in the type and amount of food supplied is key to understanding the role of dietary intake in rising non-communicable disease burden. The ability of these data to sensitively reflect climatic change and local legislative actions lend support to their continued use.

Conclusions

Our results show a temporal coincidence between import prices and availability for several imported foods. More research is needed on food prices in shops and consumer choices to interpret the behavioral implications for dietary intake and risk of NCDs. Nonetheless this association is one of the distal factors that influence consumer food prices which Drewnowski and Specter (2004) argue are potentially the most important factor in food choices and diet, especially among low and middle income consumers. This is important for NCDs as lower prices tend to characterize unhealthy energy-dense food items with low fiber. Future research should further contextualize major transformations of the local food system by studying the availability in shops and supermarkets of large stocks of imported western staples with long shelf lives. More work is needed to operationally define the context and interrelationships of food security, food prices, diet and health in Samoa (Drewnowski and Specter, 2004; Friel and Baker, 2009).

Future research should include 1) local dietary intake and reported food price data in different sectors of the population, 2) actual prices of foods in shops and supermarkets, and 3) qualitative data on cultural practices and values and the role of food in society. While we

were not able to address changing attitudes towards food with the FAO data, the role of certain foods in the Samoan culture may have influenced the trends shown here. Imported store bought foods tend to be regarded as being of higher value than locally grown foods (Fiti-Sinclair, 2004; Quested, 2004). Food advertising and promotion, especially to younger Samoans, continue to exert a strong influence on popular perceptions about the acceptability and attractiveness of imported foods, often to the detriment of traditional local foods of higher nutritional value (FAO et al., 2010).

In conclusion, these temporal data on food availability indicate increases in total energy and fat, both from imported and domestic sources, which coincide with increases in adult BMI later in the total time period. Furthermore, changes in import prices and availability largely driven by international trade and local government policies suggest the need for a behavioral perspective about food purchasing and consumption patterns. These inferences about food prices and availabilities, and associations with overweight need to be further explored with more attention to cultural and behavioral factors influencing food choices. This will allow us to complement, with more micro-level data, the national level FAO data and their implications for building models of the nutrition transition in Samoa. Describing macro- and micro-level food pricing and availability are necessary first steps toward building a complex understanding of the changing food economy in Samoa and other low-middle income countries.

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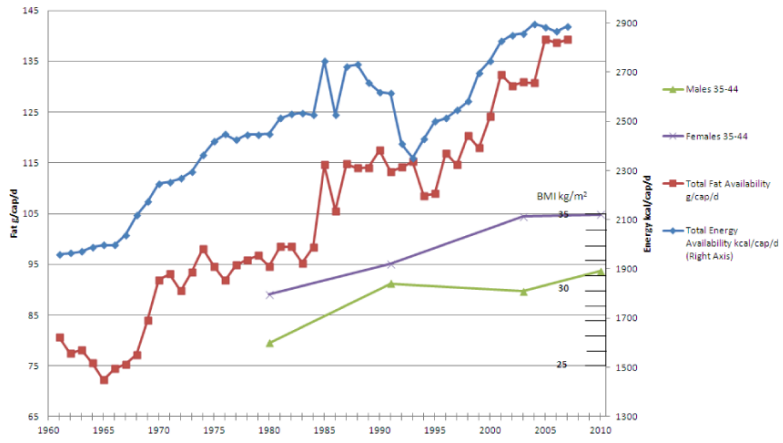


Figure One.
Total Energy and Fat Availability and Average Male and Female BMI

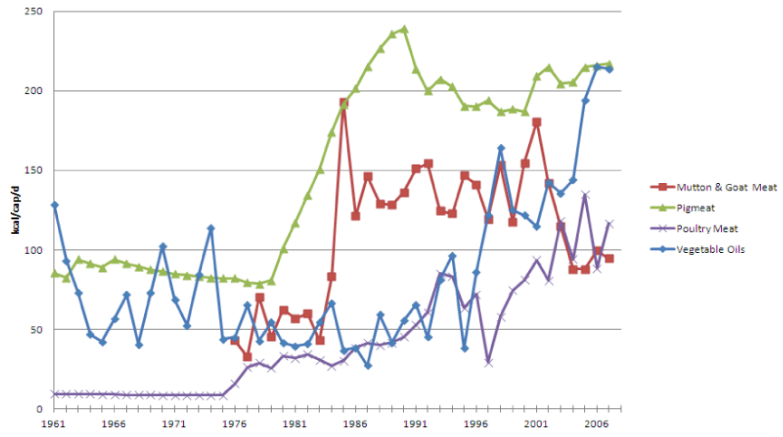


Figure Two.
Caloric Availability of Meat and Vegetable Oils

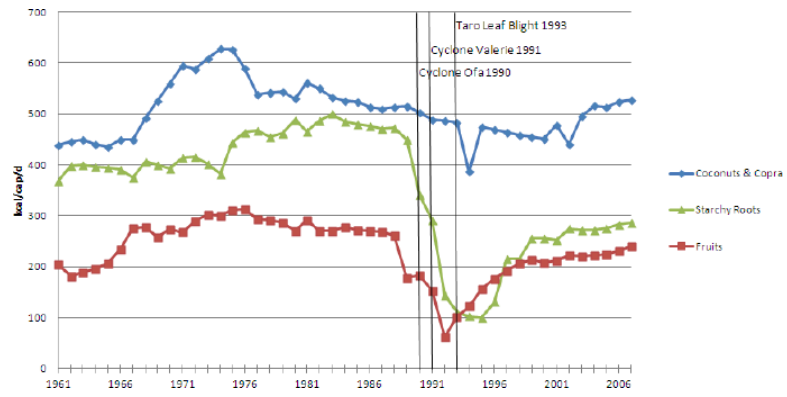


Figure Three.
Caloric Availability of Coconuts, Fruit and Starchy Root Crops

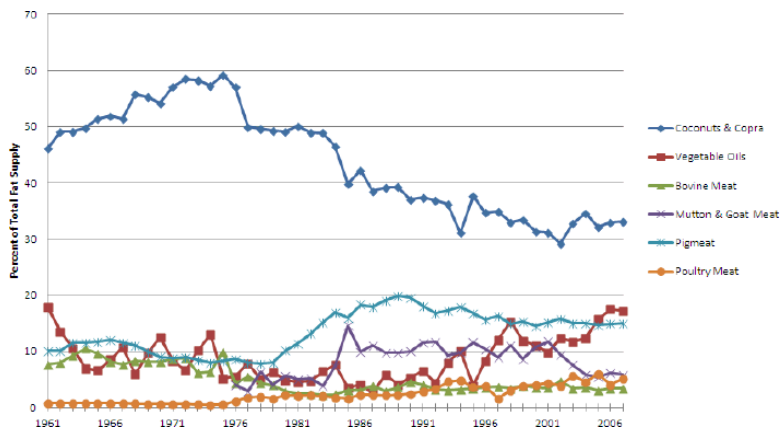
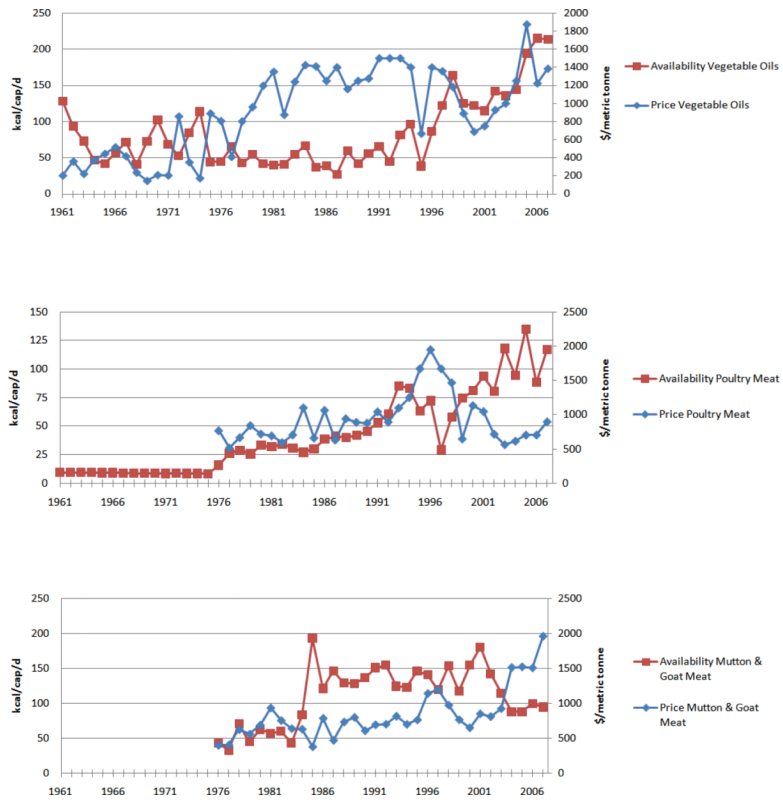


Figure Four.
Key Foods as Percentage of Total Fat Supply



Figures Five A,B,C.
Caloric Availability and Import Price of Vegetable Oil, Poultry, and Mutton