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Article

Developing a context-specific nutrient profiling system for food policy in Samoa

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Summary

The objective of this study was to develop a transparent system for defining 'less healthy' foods to underpin effective policy to reduce noncommunicable diseases in Samoa, replacing a fatty-meat ban lifted for accession to the WTO. In the absence of nutrition survey data, we calculated nutrient availability using food acquisition data from Samoa's Household Income and Expenditure Surveys. Together with published literature and local food composition data, we identified foods and nutrients (i) consumed in amounts greater than those recommended for good health and (ii) with a demonstrated causal link to health conditions of concern. Nutrient thresholds were developed based on desired level of decrease per nutrient per person necessary to reduce population intake in line with specific targets. We found average energy and sodium consumption to be higher than recommended, and foods high in sugar and saturated fat being consumed in large amounts. We selected a threshold-based, category-specific model to provide straightforward policy administration and incentivise healthy production and import, and then applied and tested nutrient thresholds across 7 threshold groups. The validation process indicated that the development of a nutrient profiling system to identify less healthy food items in Samoa provided a stronger basis for local policymaking. This study contributes to global understanding of approaches to developing a robust and transparent basis for policies to improve diets in lower income countries, and is relevant to other settings with high rates of noncommunicable diseases and similar resource and data constraints.

Key words: nutrient profiling, food policy, food promotion, food trade

INTRODUCTION

Noncommunicable diseases (NCDs) are a leading cause of death worldwide (World Health Organization, 2014a). Around 80% of the total mortality burden resulting from cardiovascular disease, diabetes, cancer and respiratory disease is carried by low- and middle-income countries (World Health Organization, 2011b). Due to the significant impact NCDs have on individuals, households, health care systems and economies (World Bank, 2011), their prevention and management has been recognized as a key target in achieving the Sustainable Development Goals (United Nations, 2015).

Health promotion interventions that create environments supportive of healthy diets, physical activity and reduced consumption of alcohol and tobacco have been recommended by the World Health Organization and others as critical to addressing NCDs (World Health Organization, 2013). Such intervention includes development and implementation of policies that effectively incentivize healthier food choices, such as taxes, marketing restrictions and informative food labels (Hawkes *et al.*, 2015).

The development and implementation of policies targeting specific foods and beverages requires a clear and transparent identification of which foods are to be targeted (i.e. a method for defining 'healthy' relative to 'unhealthy' foods). A key challenge with regard to nutrition policymaking is the absence of a broadly accepted system for categorizing foods according to nutritional composition for policy purposes (Hawkes, 2009, 2010). Nutrient profiling has increasingly become an accepted method (Rayner *et al.*, 2004, 2009, 2013; Scarborough *et al.*, 2007; Stockley *et al.*, 2007) for classifying foods, by applying thresholds across a range of different nutrients to generate a single score or grade to indicate which foods are nutritionally better than others (World Health Organization, 2011a). It is currently being used for legislative standards on nutrition and health claims in Australia, New Zealand and by countries in Europe (The European Commission, 2006; Lobstein and Davies, 2009), and as a basis for both mandatory and voluntary restrictions on the marketing of unhealthy food and beverages to children (Rayner *et al.*, 2009; World Health Organization, 2011a). However, adoption in developing countries has been limited, perhaps due to resource constraints and limited data to underpin the development of appropriate nutrient profiling models.

There is potential for nutrient profiling to underpin and strengthen a range of diet-related NCD-prevention policies in the Pacific Islands, where high rates of NCDs have generated policy priority, but policy responses have been patchy and in some cases poorly supported by a transparent evidence base (Waqa *et al.*, 2017). For example, the Samoan Government declared policy action to promote healthy diets and reduce NCDs as a top priority (Government of Samoa, 2009, 2017). Surveys have shown half (50.1%) of the adult population to be at high risk of developing and dying from an NCD (Ministry of Health Samoa, 2014), and confirmed extremely high rates of diet-related risk factors including overweight and obesity (84.7%), hypertension (24.5%) and hyperglycaemia (25.8%) (DiBello *et al.*, 2009; Hawley *et al.*, 2014). In Samoa, these conditions have a strong association with a 'modern' pattern of eating, characterized by a high consumption of processed foods containing salt, sugar and fat (especially trans-fat and saturated fat), and low consumption of foods with a protective effect—in particular, fruits, vegetables, local starchy staples and fish (Hughes, 2003; DiBello *et al.*, 2009; Baylin *et al.*, 2013).

In 2007, the Samoan Government implemented a ban on the importation of turkey tails (a high-fat meat cut, imported mainly from the USA) in an effort to curb the rise in diseases such as diabetes, high blood pressure and heart and kidney failure (World Trade Organization, 2011; Thow *et al.*, 2017b). However, following Samoa's accession to the World Trade Organisation in 2011, the ban was removed—in part, due to concerns about the scientific basis underpinning the measure (World Trade Organization, 2011). Subsequently, Samoa was requested to conduct a 'scientific study' to develop a methodologically strong, transparent set of policies to replace the turkey tail ban, to protect and promote public health (Thow *et al.*, 2017b). For Samoa, nutrient profiling draws from scientific evidence to generate a stronger health-based justification for the selection of foods subject to domestic policies, addressing concerns of the WTO regarding policy 'discrimination'. It also reduces policy ambiguity, enabling clearer policy administration and enforcement.

This paper describes the development of a nutrient profiling model to act as an evidence-based criterion to identify food and beverage products which contribute to diet-related NCDs in Samoa. It outlines how Samoa overcame data and research capacity limitations to develop a transparent system with a strong scientific basis. This approach is highly relevant for other low resource-settings looking to adopt nutrient profiling to enable more straightforward implementation of policies for the prevention and control of diet-related NCDs.

METHODS

This section sets out the method applied to develop an evidence-based and transparent nutrient profiling system for identifying healthier and less healthy food options, to underpin health-promoting nutrition policies in Samoa. We drew on the approaches used by Rayner *et al.* (Rayner *et al.*, 2004), Scarborough *et al.* (Scarborough *et al.*, 2007) and the World Health Organization in both the European Region (World Health Organization, 2015b) and the Western Pacific Region (2016), and describe both the methodological approach and the data sources. In the Results section, we present the detailed application of this model to Samoa, including methodological adaptations due to limited food and nutrient data availability, and the final model itself.

Step 1: Identifying the nutrients and foods to be targeted

To address the dual concern of problem foods versus problem diets, priority food and beverages for taxation were determined as those (i) with a demonstrated causal link to health conditions of concern among the target population, and (ii) being consumed in amounts that are more than those recommended for good health (Scarborough *et al.*, 2007).

As a proxy for individual nutrient consumption, we used household expenditure data (including subsistence production) collected through a national Household Income and Expenditure Survey (HIES). The 2013 HIES collected demographic, income and expenditure information from just under 10% of the Samoan population, and included household diary recordings of the value and volume of all food expenditure (including subsistence, or food produced by the household) during a 2-week period. Expenditure and acquisition data was converted into a proxy of household food energy and nutrient intake to establish the nutrient and food energy values for each household member, by household type (Molteldo *et al.*, 2014). Quantities of each food item were converted to calorie and micro and macro nutrient values using Pacific conversion tables (Dignan *et al.*, 2004), the US Food Composition Tables (Release 27) (Agricultural Research Service, 2015) and nutrient composition values identified through a 2011 survey of packaged foods in Samoa (Snowdon *et al.*, 2013). Quantities of fresh items were converted from 'as purchased' to 'edible portion' (Food and Agriculture Organization of the United Nations, 1953). A unit called the Adult Male Equivalent was created as indicative of 'per capita' consumption to account for aggregation of food acquisition at the intra-household level (Sahal Estime *et al.*, 2014). This approach accounts for variances in household composition and the nutritional needs of men versus those of women or children by calculating the nutrient needs of women and children as a proportion of those required by men, accounting for 'downward bias' occurring in households with a number of children of different ages (Sahal Estime *et al.*, 2014).

We grouped each of the 329 food items from the Household Income and Expenditure Survey into categories to analyse the contribution of each to nutrient intake. Initially, we used the 17 food categories from the nutrient profiling model produced by the World Health Organization's Regional Office for Europe, however the need emerged to add three new Samoa-specific categories due to either their unique place in the diet, or their significant contribution to specific nutrient intakes (Coyne, 2000). We organized all 20 food categories and all 329 foods based on their contribution to total energy, fat and sodium intake, to identify the individual foods and groups contributing most to nutrients of concern.

Foods and nutrients being consumed in higher amounts than recommended were identified through comparison to international recommendations. As there are no nutrient intake recommendations specific to the Samoan population, we compared intakes to recommended energy intakes from the Nutrient Reference Values developed by Food Standards Australia New Zealand (Australian National Health and Medical Research Council & New Zealand Ministry of Health, 2017), and United States of America Department of Agriculture nutrient intake recommendations appropriate to their multi-racial population (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010). Recommendations from World Health Organization on nutrient requirements were used as a comparison for fat, sodium, saturated fat, trans fat and sugar (given as a proportion of daily energy intake) (World Health Organization, 2003). Although the World Health Organization recommends reducing intake of 'free-sugars' (World Health Organization, 2015a), local labelling laws and food composition tables have not yet applied this terminology (Dignan *et al.*, 2004; Snowdon *et al.*, 2013), thus we refer to 'sugar' (total sugar) as a proxy for 'free-sugar' in this article.

Additional considerations for the selection of nutrients to be targeted by the model included the availability of nutrient composition information on food packages.

Step 2: Selecting the nutrient-profiling model

Currently available models vary depending on the policy application. The aim was to select a model to underpin policy(ies) that aim to incentivise healthy food consumption (and/or disincentivise unhealthy food consumption). Important considerations included (i) that the model would enable straightforward identification of healthier and less-healthy foods, (ii) that the model was developed in a transparent and systematic manner with considerations of scientific veracity and (iii) ease of application in a developing country context where both data and quantitative skills capacity may be limited.

There are two main considerations in selecting a nutrient profiling model. First, whether the model uses a threshold-based or a continuous approach to categorizing foods. Continuous models assign 'points' from different threshold bands across a number of different nutrients to produce a summative score regarding relative healthfulness based on nutrient composition; whereas threshold-based models use one or more pre-defined nutrient thresholds to classify foods as 'healthier' or 'less healthy' (Rayner *et al*., 2004). Second, whether the model applies to foods in a category-specific or across-the-board way (Scarborough *et al*., 2010). Category-specific models assess the healthfulness of foods within defined food groups (for example, one set of criteria are developed for meats and another for dairy products), to enable consumers to select healthier foods within a product category. In contrast, across-the-board models assess the healthfulness of all foods using one given standard.

Step 3: Choice of nutrient thresholds

In this step, we address the challenge of methodically selecting appropriate thresholds which would promote reductions in intakes of nutrients of concern. Nutrient threshold selection was informed by the desired outcome to designate foods as 'less healthy', which would underpin policies to disincentivise 'less healthy' foods. We based our selection of thresholds on the desired level of decrease per nutrient per person necessary to reduce population intake in line with specific targets.

Calculating appropriate criteria based on dietary intake for the relevant population normally requires modelling of detailed dietary intake data (from a nutrition survey) for comparison against intake recommendations (Rayner *et al*., 2004; Scarborough *et al*., 2007). The data is used to determine the desired percent (%) level of decrease per nutrient per person, and that percent (%) decrease is then applied to average nutrient contents for each food type to determine a 'threshold' for that food type.

In lieu of population survey, we used our comparisons of dietary intakes in Samoa to recommendations (Step 1) to identify an appropriate rate of decrease for nutrient intake. To determine thresholds, we first examined mean and median values for energy, total fat, saturated fat and sodium of each food category using composition data from the Samoa Store Food Survey (Snowdon *et al*., 2013) and the Pacific Nutrient Composition Tables (Dignan *et al*., 2004). As a second step we applied the desired rate of decrease required to achieve population recommendations to mean nutrient contents for each food type (UK Food Standards Agency, 2003).

Due to the complexity of administering nutrient thresholds across 20 categories, a third step in the analysis involved collapsing the 20 food categories into 7 threshold groups. Threshold groups were aligned to the Samoan Guide to Healthy Eating as well as nutrient characteristics and similarities in nutrient thresholds (Table 4).

Step 4: Applying and validating the model

We assessed nominated thresholds against other reputable nutrient profiling tools including the Pacific Salt Reduction Targets (World Health Organization, 2014b), Heart Foundation's Tick Program (Heart Foundation of Australia, 2016), the Danish Code of responsible food marketing communication to children (Danish Forum of Responsible Food Marketing Communication, 2008) and the European Office of the World Health Organization's nutrient profiling model for marketing restrictions (World Health Organization, 2015b) to determine whether they were appropriately restrictive. We then tested proposed thresholds against our food composition dataset to examine whether thresholds appropriately targeted 'discretionary foods'. Validation and testing of the model was based on expert input from the Samoan Ministry of Health (in person), and experts from the WHO Country Office in Samoa and the Food and Agricultural Organization (via email communication). Officials from the Ministry of Health were provided with a document featuring all foods that did and did not meet the thresholds of the model and asked to review (i) contextual appropriateness of food categories and threshold groups; (ii) feasibility for use by Government, food industry and stakeholders and (iii) functionality, assessed by running a 'test sheet' containing 10 self-selected food items through the model.

RESULTS: A MODEL FOR SAMOA

Choice of nutrients and food components

Food containing nutrients of concern in high amounts

An analysis of the nutrient composition of household food purchases in Samoa found the foods with the highest density of energy and fat included fats and oils, savoury snacks, cakes and biscuits, confectionary, cheese and pastas, rice and grains, processed meats and coconut products (Snowdon *et al.*, 2013) (Table 1). Food categories with the highest energy and fat density per 100 g were all packaged, processed foods and beverages, with the exception of coconut products. Food categories with the highest sugar density included confectionary, sauces, cakes and sweet biscuits and breakfast cereals, edible ices and beverages. Foods highest in sodium included sauces and spices, bread, processed meats, savoury snacks and convenience foods (including packet noodles).

Those food categories providing higher proportions of saturated fat, sugar and salt (as per Table 1), and contribution little to intakes of beneficial nutrients were regarded as 'discretionary foods', and prioritized for targeting under the model. Discretionary food categories included fats and oils, savoury snacks, cakes and sweet biscuits, confectionary, convenience foods, sauces and spices, edible ices, table salt and sugar-sweetened beverages.

Nutrients consumed in amounts that are more than those recommended for good health

Analysis of the 2013 Household Income and Expenditure Survey data showed that an average of 3852 kcal of energy, 121 g of protein, 3449 mg of Sodium and 97 g of fat were available to the average Adult Male Equivalent (AME) in Samoa (Table 2).

Comparison against international recommendations indicated that the average energy availability per AME was approximately 50% higher than recommended for an average active male aged 19–51, and 100% higher than required for the average sedentary male, based on guidance from the USA (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010).

Fat contributed 23% to energy availability, complying with WHO recommendations that fat not comprise more than 30% of total energy intake (Food and Agriculture Organization of the United Nations, 2001; World Health Organization, 2003). However, we considered that intake of dietary energy was excessive, and should a more appropriate energy intake of 2000 kcal/adult male/day be consumed, then dietary fat intake would need to be reduced to 74 g per AME from 97 g per AME to meet WHO guidelines. Total sodium availability was approximately 50% higher than intakes recommended by both WHO (World Health Organization,

Table 1: Energy, fat, sugar and sodium density of packaged and fresh foods in Samoa

Commodity description	Average nutrient density of foods in Samoa[a]			
	Mean energy (kj/100 g)	Mean fat (g/100 g)	Mean sugar (g/100 g%)	Mean sodium (mg/100 g)
Fats and oils	3030.0	81.0	0.0	328.3
Savoury snacks	2039.0	22.9	7.9	667.4
Cakes, sweet biscuits, etc.	1938.0	19.4	31.4	355.5
Cheese	1594.8	31.5	0.9	713.3
Breakfast cereals	1581.4	2.8	30.0	484.8
Pasta, rice, grains	1514.2	10.4	2.3	314.2
Coconut products[b]	1289.0	28.6	—	11.0
Confectionary	1, 266.2	13.0	55.8	94.3
Processed meats (incl canned)	1040.6	17.6	3.5	903.9
Breads[a]	956.3	6.2	6.9	550.5
Meat, poultry, fish, eggs[b]	909.6	13.9	—	162.0
Convenience foods	897.0	8.3	3.9	1235.7
Edible ices	753.5	9.4	19.7	50.0
Other milk products	666.3	8.4	10.3	56.7
Sauces and spices	554.9	6.0	21.1	1685.1
Root crops[b]	459.2	1.1	—	28.0
Beverages	374.2	2.3	17.1	55.7
Processed fruit and vegetables	328.8	2.3	8.7	329.0
Fruit and veg (fresh and frozen)[b]	190.7	0.7	—	16.2
Table salt	0.0	0.0	0.0	38758.0

Source: [a]Energy density of food determined using data from Samoa Store Survey (2011), Snowdon *et al.* (2013).
[b]Average nutrient density calculated using a sample of corresponding fresh foods from the Pacific Food Composition Tables (30). Sugar composition was not available in these tables.

Table 2: Average daily expenditure, volume and nutrients available per AME

Volume kg	Energy (kcal)	Protein (g)	Fat (g)	Sodium (mg)	Iron (mg)	Vit. A (μg)
3.3	3852.6	121.8	96.9	3449.9	30.6	484.2

2012) and the Nutrient Reference Values developed by Food Standards Australia New Zealand (Australian National Health and Medical Research Council & New Zealand Ministry of Health, 2017). It was not possible to determine total sugar intake from the HIES dataset, given the limitations of the Pacific Island Food Composition Tables in that regard. However, out of a total 3852 kcal purchased per AME per day, 589 kcal (15%) came from foods which are typically 'high in sugar', including plain sugar (7%), cakes and biscuits (15%), beverages (9%), edible ices (7%) and fruit (13%).

Our analysis identified that the main source of energy in the Samoan diet was root crops (providing 47% of available calories) (Table 3). Confectionary (including sugar), poultry and processed meats (including canned meats) were also significant contributors to calorie availability.

The food group making the largest contribution to sodium intake was table salt (41%), followed by processed meat, fish and poultry (18%) and convenience foods (including noodles) (9%) (Table 3). Individual foods contributing most to sodium included canned mackerel (9%), instant noodles (9%), bread (6%), soy sauce (3%) and canned beef (2%).

Just over one-quarter (25.7%) of fat consumed in Samoa came from fresh meat, poultry, fish or eggs, while 19% came from *popo* (coconut), 14% from processed meat and 10% from fats and oils including butter, ghee and vegetable oil (Table 3). Additional analysis showed that 19 of the top 20 foods contributing to fat (comprising 71% of total fat intake) were those deemed as being proportionally high in saturated fat. Data on trans fatty acids were not available through the Pacific Food Composition Tables and was not recorded for the majority of items on the Samoa Store Survey; however, the volume of processed foods being purchased in Samoa, and the number of palm-based vegetable oils available, would indicate that it is being consumed in high amounts.

We examined the foods providing the most substantial contribution to Vitamin A and Iron intake to ensure that interventions to reduce consumption of foods high in fat, salt and sugar would not inadvertently exacerbate deficiencies of nutrients important to growth, development and human function (Table 3). The main sources of Vitamin A available in Samoa were fresh fruit and vegetables, canned fish, root crops, fats and oils, eggs and milk. Root crops (61%), in particular taro, provided the greatest contribution of iron to the Samoan diet, significantly more than came from fresh meat, poultry, fish and eggs (10%) or processed meat and fish (8%). Although foods like taro are not especially high in iron, they are eaten in such large quantities that they make an important contribution to intakes.

Samoa's Food (safety and quality) Regulations (2015) require that food and beverage products declare energy, protein, fat, sodium and carbohydrate composition. A 2011 store survey showed that around 70% of food products available in Samoa list saturated fat content on their labels (Snowdon *et al*., 2013).

These data suggest that to reduce NCD risk in Samoa, nutrients that could be targeted for reduction included fats (especially saturated fats), sugar and sodium, particularly in food categories determined as 'discretionary foods'.

Choice of model

We determined that the most appropriate model would be threshold-based to provide a straightforward nutrient criteria for policy administration, incentivising consumption, production and/or import of healthier foods. We determined that it should be category specific to provide an incentive for consumers and producers/importers to switch to healthier products within categories, and to incentivise movement from less healthy categories to healthier categories. A threshold-base of 'per 100 g' was selected to be consistent with food labelling legislation in Samoa.

Selection of nutrient thresholds

Nutrient thresholds were selected for food categories that either (i) contained a high density of nutrients being targeted for NCD prevention or (ii) contributed significantly to overall intake of nutrients linked to NCD risk (Table 3).

We determined that goals established by the consumption analysis in Step 1 above included to:

- Reduce energy intakes by at least 30%
- Reduce saturated fat to <10% of energy
- Reduce fat to <30% of energy
- Reduce total sugar intake to <10% total energy
- Reduce sodium content by 50%
- Target discretionary foods as a priority

Table 3: Top contributors to intakes of nutrients, by food category (% contribution to total intake)

Calories	Fat	Sodium	Vitamin A	Iron
Root crops (47%)	Meat, poultry, fish, eggs (26%)	Sauces and spices, including table salt (45%)	Vegetables (fresh/frozen) (26.3%)	Root crops (6.4%)
Confectionary (incl. sugar) (8%)	Coconut products (21%)	Processed meats (incl canned) (18%)	Canned fish (21.6%)	Taro (58.5%)
Poultry (6%)	Processed meats (incl canned) (15%)	Convenience foods (9%)	Root crops (10.1%)	Meat, poultry, fish, eggs *– Fresh fish (1.5%)*
Processed meats (incl canned) (6%)	Fats and oils (11%)	Meat, poultry, fish, eggs (8%)	Fats and oils (10.1%)	Processed meats (incl canned) (8.3%) *– Canned fish (5.5%)*
Pasta, rice, grains (5%)	Beverages (5%)	Breads and Staple biscuits (7%)	Fruit (7.3%)	Coconut products (3.5%)
Coconuts and coconut products (5%)	Savoury snacks (4%)	Root crops (3%)	Meat, poultry, fish, eggs (5.3%) *– Eggs (3.2%)*	Fruit and vegetables (3.3%)
Breads and staple biscuits (4%)	Cakes, sweet biscuits, etc. (3%)	Savoury snacks (2%)	Edible ices (5.2%)	Beverages (2.4%) *– Sugar-sweetened beverages (1.9%)*

Source: Contribution to intake calculated by report authors using data prepared for report by FAO (2017).

Highly processed discretionary foods (including sugar-sweetened beverages, savoury and sweet snacks, cakes, confectionary and commercial sauces) were prioritized for inclusion in the model due to their significant contribution to intakes of energy and sodium intake by the population; as well as their high sugar, fat and sodium density. Thus a nutrient threshold was determined for fat, sugar and sodium across each of these food categories. For threshold group 'Energy-dense foods', a sodium threshold of 330 mg per 100 g was selected as 50% of the mean sodium content of 'savoury snacks' and the sugar threshold of 15 g per 100 was selected to as 50% of the mean sugar content of 'cakes and sweet biscuits' (Table 4). The threshold for fat was set close to the mean fat content of those groups (at 20%), because these categories were not key contributors to fat among this population. The sodium threshold was significantly more restrictive than the range recommended in the Pacific Salt Reduction Targets (450–800 mg/100 g) (World Health Organization, 2014b), but less restrictive than the value for savoury snacks in the nutrient profiling model developed by WHO for the Western Pacific Region (40 mg/100 g) (World Health Organization, 2016).

The threshold group 'Body-building Foods' (including fresh, frozen and processed meats and fish) contributed a total of 41% to total fat intake per adult male equivalent and 26% to sodium intake. Due to the significant contribution of foods in this category to those nutrients, and the availability of lower-sodium, lower-fat alternatives (e.g. tinned tuna, chicken fillets) it was determined that thresholds for sodium and fat should be applied so as to incentivise an intra-category switch. A threshold of 500 mg was selected as being around 50% of the mean sodium content for 'processed fish and meats', and a threshold of 15 g/100 g of fat was selected as being around 30% lower than the mean fat content of that category (Table 4). These values were found to be slightly more restrictive that WHO's nutrient profiling model for the Western Pacific Region (20 g/100 g fat and 680 mg/100 for sodium), but the sodium threshold was within recommended ranges in the Pacific Salt Redcution Targets (430–600 mg/100 g) (World Health Organization, 2014b).

The threshold group 'Energy Foods' contributed to over 17% of sodium intake by Samoans, and therefore a threshold of 500 mg/100 g was applied, with the aim of reducing sodium content of the category with the highest sodium density (mixed prepared convenience foods) (Table 4). This was deemed comparable to the sodium threshold selected for 'prepared foods' in WHO's nutrient profiling model for the Western Pacific Region (400 mg/100 g). Due to the high sugar and fat composition of many convenience foods (fat) and breakfast cereals

Table 4: Proposed nutrient profiling model for Samoa

Threshold group	Commodity description	Food-based dietary guideline category	Thresholds			
			To be considered 'healthier', product must contain less than:			
			Fat g/100 g	Saturated fat g/100 g	Sugar g/100 g	Sodium mg/100 g
1	Confectionary Cakes, sweet biscuits, etc. Savoury snacks Edible ices Sauces and spices	Energy dense and/or nutrient poor foods	20		15	330
2	Beverages		4		5	0
3	Breakfast cereals Mixed prepared convenience foods Breads Pasta, rice, grains	Energy foods	15		15	500
4	Processed meats (incl canned) Meat, poultry, fish, eggs Other milk products Cheese	Body-building foods	15			500
5	Fats and oils			20		
6	Table salt					n/a
7	Processed fruit and vegetables Fruit and vegetables (fresh and frozen) Root crops Coconut products	Protective foods				

(sugar), this group was also subjected to fat and sugar thresholds, based on reducing mean nutrient values for those groups. The sugar threshold at 15 g/100 g matched that recommended for cereals in WHO's nutrient profiling model for the Western Pacific Region.

A threshold level for saturated fat (20 g/100 g) was applied to fats and oils because of their significant contribution to fat intake and high saturated fat content. This threshold matched that set for fats and oils by the Heart Foundation's Tick program and in WHO's nutrient profiling model for the Western Pacific Region.

Ideally the thresholds established by the steps outlined above would both incentivise an intra-category switch by consumers, as well as potential reformulation by manufactures (incentivised by the policy limitations being applied).

We exempted protective foods (fruit and vegetable products, including fresh, dried, frozen and canned) and coconut products (except oil) from nutrient thresholds because of the important role they play in the diet and their significant place in Samoan culture, cooking and eating. A similar approach was taken by the Pan American Health Organization, where all minimally processed foods were exempted from the nutrient profiling model to promote consumption of minimally processed foods over ultra-processed alternatives (Pan American Health Organization and World Health Organization, 2016).

Validation and testing

Our validation was limited to expert consultation and an assessment of our thresholds against other reputable models. We also returned to our nutrient composition data to ensure that thresholds provided an appropriate indication of healthfulness. During expert consultation, four foods were queried by staff in the Nutrition Unit of the Ministry of Health as possible anomalies and reviewed against the Pacific Food Composition Tables (Dignan *et al.*, 2004), Samoa Store Survey (Snowdon *et al.*, 2013) and the USDA nutrient database (Agricultural Research Service, 2015) to ensure they were appropriately categorized. One threshold was modified as a result of the validation process; the allowable sodium limit in ‘Body-building foods’ (fresh and processed meat, poultry, fish, eggs and dairy) was lifted by 50 mg/100 g on the basis that a number of canned fish products contained 10 mg/100 g over the selected threshold. This decision was made because canned fish was deemed to be an important (and affordable) source of protein, iron and Vitamin A in the Samoan Diet (analysis shown in Table 3). No further anomalies were found, and the expert group agreed that it both provided an appropriate indication of the healthfulness of foods, and was feasible for use by Government, food industry and stakeholders. It was believed that this list would incentivise reformulation and subject a significant number of ‘unhealthy’ foods to tax/policy.

DISCUSSION

This study outlines a method for developing a system for categorizing food as ‘healthier’ and ‘less healthy’, addressing a critical need for a stronger evidence-base for health-promoting nutrition policies designed to prevent diet-related NCDs in low- and middle-income countries. This method addresses concerns raised by the World Trade Organization with regard to the need to develop transparent, health-based justifications for restrictive food policies. A number of countries have now been called before the WTO to provide scientific evidence for the effectiveness of health promoting measures to protect against diet-related NCDs, including interpretive labelling schemes (Thow *et al.*, 2017a) and import restrictions (Thow *et al.*, 2010), and left with the burden-of-proof to justify such measures. There is potential for countries to adopt more systematic and transparent systems for defining unhealthy foods (to which restrictions could be applied) as a way to minimize the likelihood of trade-related concerns being raised regarding the basis of domestic nutrition policy interventions (Snowdon and Thow, 2013; Thow *et al.*, 2017a). The approach presented here could be a useful reference in informing future national-level policy action on NCDs.

Our use of local household expenditure data, combined with international best practise approaches and standards, has resulted in a model which has been tailored to the health, nutritional and cultural context of Samoa, thus providing a stronger basis for local policymaking. This method took into account the data constraints that are common to low- and middle-income countries (Pitt *et al.*, 2016; Bell *et al.*, 2017), and is therefore likely to be useful elsewhere. The development of an evidence-based criteria using locally available food and disease data has strengthened the model’s acceptability by policy makers responsible for approving or refuting policy decisions. A particular strength of this model is its alignment with the Samoan food-based dietary guidelines and its administrative simplicity.

Nutrient profiling as an approach has a number of limitations, including that it weights the value of foods on nutrient content alone, without taking into account how often they are consumed, and in what context (Rayner and Scarborough, 2014). Some researchers argue that evaluating and grading individual foods in this way (independent of the context in which they are eaten) oversimplifies the complex relationship between foods, diets and health (Nicklas *et al.*, 2014; Rayner and Scarborough, 2014). Rankings of ‘healthfulness’ are, to a degree, reliant on decisions and assumptions about what nutrients should be included in the model at the outset, and what weighting they should be given (Scarborough *et al.*, 2007; Rayner and Scarborough, 2014). Major discrepancies between food classifications and the varying degree of validation across models serves to moderate their performance as accurate tools, inviting questions of ‘robustness’ (Azaïs-Braesco *et al.*, 2006; Scarborough *et al.*, 2013).

There were other limitations to the methodology being applied here. First, use of household expenditure information as a proxy for food, energy and nutrient intake may overestimate consumption due to limitations in the conversion of food quantities into nutrient content (Molteldo *et al.*, 2014; Sahal Estime *et al.*, 2014). Second, legislation around nutrient labelling, and the availability of food composition data for the Pacific, limited the nutrients that could be considered for inclusion in the model. Lastly, validation of this model was limited to comparison against other reputable models and expert consultation, due to the data constrains that have underpinned this study. Despite these challenges, nutrient profiling remains a useful and transparent approach for identifying foods associated with NCD risk (World Health Organization, 2011c), resolving a policy problem faced by governments universally, that is, creating a clear system for identifying which foods should be subject to policy interventions, and enabling a more straightforward monitoring and enforcement.

In applying this method, we have created a nutrient profiling system which is aligned to the dietary patterns and concerns of Samoans. The Government of Samoa has indicated that it is considering the potential for this nutrient profiling system to be appended to national food regulations, and used as the basis for a range of health promoting interventions for improving diets and preventing NCDs, such as restrictions on the marketing of foods to children, school-based food standards, interpretive labelling measures, mandatory nutrient limits for manufacturers and the application of fiscal policies. The adoption of a single nutrient profiling system for multiple policies has the potential to reduce administrative burden and confusion, and demonstrate a consistent approach to food promotion (Sacks *et al.*, 2011).

AUTHORS' CONTRIBUTIONS

ER and AMT were involved in all aspects of the study and ER drafted the manuscript. TN provided supervision, representation and review to the manuscript. TM contributed HIES dataset analysis and provided technical review of the manuscript. CB provided coordinated the partnership and provided technical inputs to the research. All authors read and approved the final manuscript.

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