Original Article

Quantitative estimates of dietary intake in households of South Tarawa, Kiribati

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Background and Objectives: Malnutrition is a public health problem especially among the Pacific Small Island developing nations. This study assessed malnutrition with dietary intakes in households of South Tarawa, Kiribati, a West Pacific Island Nation State. **Methods and Study Design:** A cross-sectional community-based study design was used. One hundred and sixty-one households were selected from Betio, Bikenibeu and Teaorereke towns using a systematic random sampling method. About 35% each of the households was selected from Bikenebue and Besio while 30.4% was selected from Teaoraeke. Family (including children) dietary surveys including 24-hour dietary recall were administered to assess adequacy of nutrient intakes and dietary diversity using Household Diet Diversity Scores. A 3-day weighed food record was collected on a sub-sample. Data were analysed using FoodWorks Pro 8 for nutrient intake and Statistical Product for Service Solution (SPSS) version 21 for descriptive statistics. **Results:** Sixty-one percent of the subjects had the lowest dietary diversity, 36.3% had a medium dietary diversity and only 2.7% had the highest dietary diversity. Based on the weighed food record results (n=29), male subjects of all age groups had adequate intakes of riboflavin, niacin, vitamin C, magnesium, iron and zinc, but had high intakes of protein and sodium; and low intakes of potassium and calcium. Female subjects had adequate intakes of vitamin C, iron, magnesium and zinc, but had high intakes of protein and sodium; and low intakes of potassium and calcium. **Conclusions:** Across all groups, 61% of the adult Kiribati population studied showed low dietary diversity, and a high prevalence of multiple micronutrient deficiencies.

Key Words: nutrient adequacy, dietary intake, dietary diversity, households, Kiribati

INTRODUCTION

Micronesia is a region in the western Pacific Islands comprising approximately 2100 islands with a total land area of 2700 km^2. It has four main island groups which are the Caroline Islands (Federated States of Micronesia and Palau), the Gilbert Islands (Republic of Kiribati), the Mariana Islands (Northern Mariana Islands and Guam) and the Marshall Islands.[1] Kiribati contains a chain of sixteen atolls and coral islands with a population of 110, 136 from the 2015 census population and a GDP per capita as low as US$1,651.[2,3]

It has been suggested that 'the Pacific islands including Kiribati are experiencing nutrition transition'.[4] However, no contemporary data are available and the current nutrition situation is therefore unclear. A shift in dietary patterns has occurred since the 1980-90s, from reliance on indigenous traditional diets, characterised by the consumption of legumes, tubers, fresh fish and meat, fruit and green leafy vegetables, to westernised diets, based on refined rice, oils, fatty and processed meats, and confectionary.[5,6] Moreover, consumption of pre-packaged, processed and ready-to-eat meals has been on the rise, and is projected to increase.[7] This increases the risk of neglecting traditional food production systems, which in turn increases the population's vulnerability to food insecurity –defined as the state of being without reliable access to a sufficient quantity of affordable, nutritious food. Furthermore, such diets are major contributor to the 'triple burden of malnutrition' (the coexistence of food insecurity, undernutrition, and the state of being overweight or obese) manifesting as non-communicable diseases (NCDs) in the region.[8,9] NCDs cause 70-85% of all deaths in the region[10] and the prevalence of obesity and diabetes is among the highest in the world.[11] Concurrently, the incidences of micronutrient deficiencies continue to be main public health concerns.[12,13]

Beyond the shift in intake patterns, a suboptimal dietary diversity (a defined dietary index used to assess overall diet quality) is often observed.[14] This is a common problem among socioeconomically deprived populations, particularly in low and middle income countries, because their diets are largely dependent on cheap starchy staple foods, with limited amounts of fresh fruits and vegeta-

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bles. Hence, communities that are socially and economically disadvantaged may be overly-exposed to the effects of unhealthy diets because of greater economic constraints, low levels of awareness and limited access to healthier choices.

The aim of this research was to quantitatively assess dietary patterns, food intake, and dietary diversity of adult householders in South Tarawa, Kiribati. The work is part of a baseline survey for the Kiribati Health Champions (KHC) programme[15] and one of the few studies in Small Island Developing States (SIDS) that reports nutritional status using dietary intakes of households. It is also the only SIDS study in which weighed food records have been used to validate 24-hour dietary recall information in the dietary assessment. The findings from this study provide a benchmark against which progress made by the KHC group in the target communities can be measured.

METHODS

Study area

South Tarawa is the capital of the Republic of Kiribati which is home to approximately half of Kiribati's total population (114,295), and most of the government, commercial and education facilities.[16]

Enumerator composition and training

Enumerators were drawn from all three Catholic Parishes in South Tarawa: Betio, Teraokee and Bikenibue. The enumerators were selected by the Director of the Women's Development Centre, Kiribati and members of the Catholic Parish Women Executives, based on knowledge, fieldwork experience, and community engagement. Ten enumerators were trained and field work was conducted in teams of two. A translator was present during training, fieldwork and initial data cleaning. The training was done for 5 days and it covered best practices, ethical behaviour, sampling protocols and the questionnaire instruments. It also included a field test of some of the instruments and a final revision of the instrument based on the enumerators' field experience. Serving/portion sizes were developed for some of the foods with input from the enumerators for better applicability and understanding of the dietary assessment instruments. These were continuously updated or verified until the end of the survey as new foods/dishes/menus were identified from participant responses.

Sampling methodology

A sample of 161 HHs from Betio, Teraokee and Bikenibue was selected for the baseline survey using systematic random sampling method. About 35% each of the households was selected from Bikenebue and Besio while 30.4% was selected from Teaoraeke. The sampling frame was any household with at least a mother/father and child/dren living in the same building and cooking/eating from the same pot. It is a household study and the individuals were responding on behalf of the households, with the exception of the individual weighed food records, which were recorded at the individual level. After estimating the total number of households at each site, every third household was approached and invited to participate in the study. Respondents were mostly adult female members of the households (HHs) (≥18 years of age) who were involved in cooking/purchasing of the food. In most HHs, these were married women, however, HHs where young unmarried women and men were in-charge of the kitchen were also included. No incentives were provided.

Ethical standard disclosure

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving study participants were assessed and approved as Low Risk under Massey Ethics Committee System with Application No 4000018013. A research permit was also obtained from Kiribati Immigration with RP No 14/2017. Written and verbal informed consent was obtained from all subjects. Verbal consent was witnessed and formally recorded.

Data collection

All data were collected in August and September, 2017, using standardise protocol for 24-h food recall and weighed food record, both of which are instruments of choice in studies of this type.[17] An individual single 24-h food recall survey, using a, was administered by a trained person on a random day to minimise the effects of day-to-day differences. During the 24-h recall, participating women (118) and men (43) were asked to name all foods and drinks consumed the preceding day as well as the time these foods or drinks were consumed. Names of dishes and all ingredients used were recorded. The amount of food consumed was expressed using common household measures such as a big spoon, a small spoon, a ladle, a cup, a glass and a tea glass. The respondents were shown visual aids (photographs of servings) to assist them with accurate reporting of food intakes. Preparation techniques of the foods and occasions they were consumed were also recorded. The food and drink consumption data was not restricted to any quantity or form for any of the items consumed, and all items were included in the analysis.

A three-day weighed food record was obtained from a sub-sample of 8 households with 29 members. Measurements of the food were done using a modified standard procedures.[18,19] In particular, household dietary/food scales were used to weigh all raw food ingredients, all cooked food, and individual food portions per person at each meal. Leftovers and inedible portions of each meal were also weighed. Data obtained were used to validate the 24-h food recall.

Dietary diversity and nutrient adequacy

Dietary diversity (DD), defined as the number of different foods or food groups consumed in the previous day, was measured using Dietary Diversity Score (DDS). DDS for each individual was calculated by summation of the number of food groups recorded on the 24-h food recall.[20] Any quantity of any food group consumed at least once per day was taken into account. Therefore, DDS was calculated without considering a minimum intake for the food group. Eleven food groups were used in this study. Subjects were categorized as Low DD (consumption of

≤4 food groups), Medium DD (5-6 food groups) and High DD (≥7 food groups).[21]

Nutrient adequacy was measured from the weighed food record through computing the Nutrient Adequacy Ratio (NAR).[22] NAR was calculated for energy and 12 nutrients including vitamin A, vitamin C, vitamin B-1, vitamin B-2, niacin, folic acid, vitamin B-12, calcium, iron, zinc, magnesium, and protein. The mean probability of adequacy across 12 nutrients was calculated using the Recommended Nutrient Intakes (RNIs).[19]

Data analysis

Preliminary dietary analysis was done using FoodWorks 8 Pro, Xyris (2009) Ltd., Australia for the 24-h dietary recall and nutrient intake assessment. All data were entered into SPSS for descriptive analysis involving frequencies, percentages, means and standard deviations. The nutrient intake assessments of the subjects were compared with the FAO/WHO/UNU[23] requirements and the Nutrient Reference Values for Australia and New Zealand.[24]

RESULTS

The response rate for this study was 98.2%, 73% were women, and the majority of respondents were aged between 25-55 years (Table 1). Most respondents (over 60%) had secondary school education as their highest formal education.

The majority of subjects (more than 95%) consumed sugar, cereals food crop and fish and sea foods (Figure 1). Only a small proportion of participants consumed dairy products (12%), vegetables (10%) and fruits (5%). Over a 24 h period, 90% of the subjects had consumed rice-based dishes, 78% consumed flour-based dishes, 33% consumed breadfruit based dishes and only 3% consumed cassava-based dishes (Figure 2).

Only 3% of subjects (four individuals) showed the highest dietary diversity score of seven or more food groups (Figure 3). By contrast, at the other end of the scale, 61% (98 individuals) fell into the lowest dietary diversity category (four or less food groups). The remaining 36% (59 people) had medium dietary diversity.

Estimated protein, vitamin and nutrient intakes for men and women are presented in Table 2 (based on 24-hour dietary recall) and Table 3-4 (based on weighted food records). Tables 2-4 also show average intakes compared with nutrient reference values.

On average, both male and female subjects consumed below the recommended nutrient intake (RNI) for the following vitamins: vitamin B-1 (61.7% and 56.4%, respectively), vitamin B-2 (52.1% and 53.6%) and vitamin A (RE) (46.7% and 37.5%). They had adequate intake for niacin (119.2% and 109.1%) and vitamin C (122.0% and 165.0%) (Table 2). Of the minerals, both male and female subjects consumed below recommended intake values for: potassium (49.4 and 57.1%), magnesium (57.9 and

Table 1. Socio-demographic characteristics of the 161 respondents representing the households

Variables	Frequency	Percentage (%)
Sex		
Men	43	26.7
Women	118	73.3
Age (years)		
18-25	9	5.6
26-35	37	23.0
36-45	56	34.8
46-55	44	27.3
>55	15	9.3
Highest level of formal education		
No formal education	3	1.9
Primary school	41	25.5
Secondary school	98	60.9
Tertiary/Higher school	7	4.3
No response		7.5

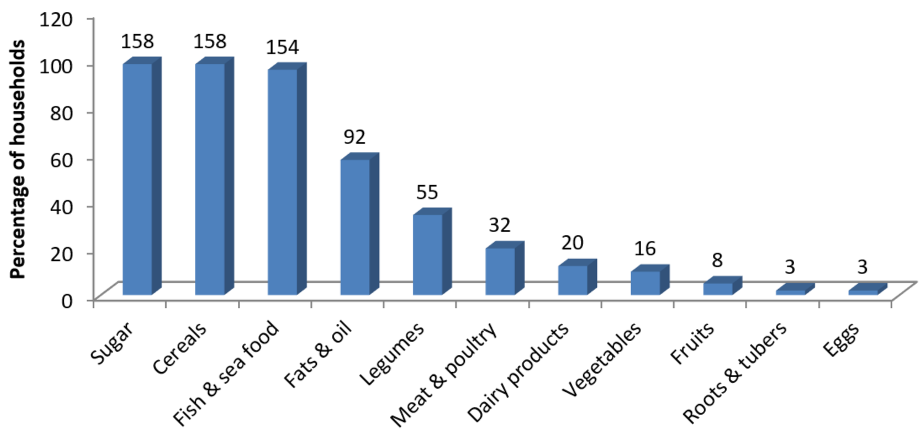

Figure 1. Food groups consumed by the subjects in a 24-h dietary recall (Number above each bar is number of households)

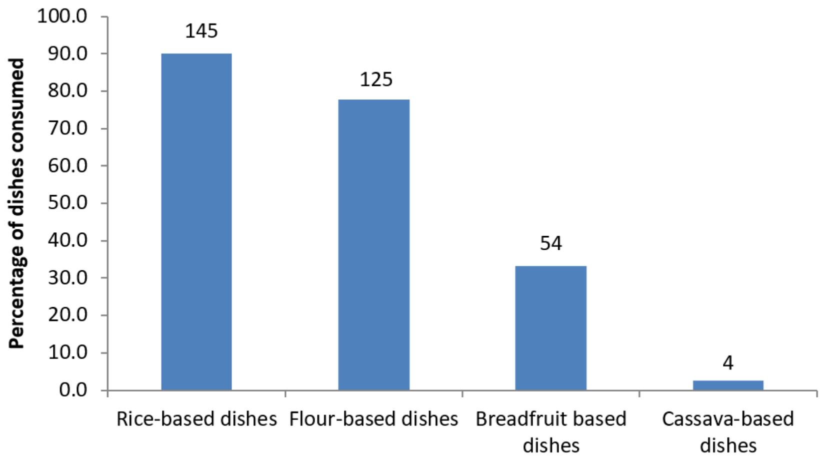

Figure 2. Dishes consumed by the subjects in a 24-h dietary recall (Number above each bar is number of households)

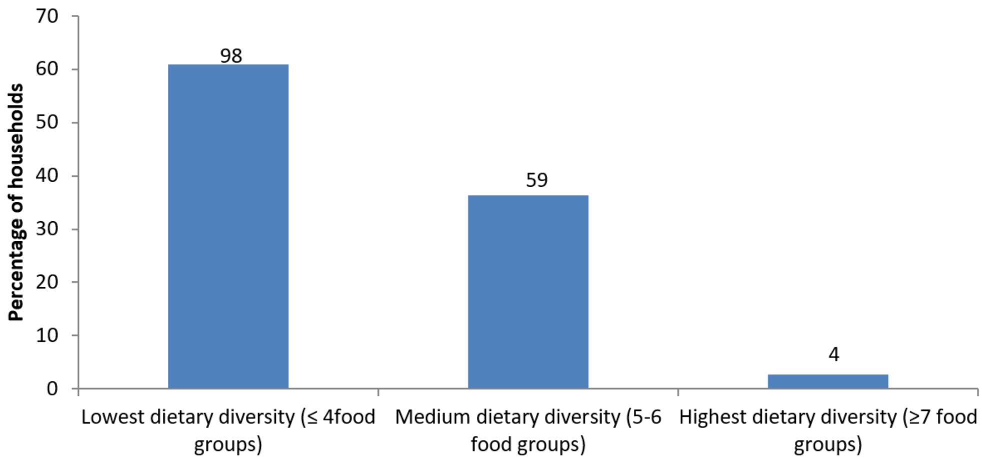

Figure 3. Dietary diversity of the subjects (Number above each bar is number of households)

50.6%), calcium (26.5 and 20.51%), iron (86.1 and 31.3%) and zinc (45.6 and 62.6% respectively); and above the recommended intake for sodium.

The male subjects of all age groups showed adequate intakes of vitamin B-1, B-2 and C; niacin; iron; magnesium and zinc, but had high intakes of protein and sodium and low intakes of potassium and calcium (Table 3). Female subjects of some age groups had adequate intakes of vitamin C, magnesium, iron and zinc, but had high intakes of protein and sodium and had low intakes of potassium and calcium (Table 4).

DISCUSSION

Both a low dietary diversity and high prevalence of multiple micronutrient deficiencies exist in Kiribati adults. The majority of subjects consumed non-traditional diets predominantly consisting of refined rice and flour based products. The limited availability and affordability of nutritious foods is likely to have a major bearing on both obesity and micronutrient malnutrition.

Aspects of these findings confirm a trend suggested in earlier work. The 2006 STEPwise survey showed that average consumption of fruit and vegetables in Kiribati was well below internationally recommended levels.25 The 2015 STEPwise survey showed that 98.4% adults ate less than 5 servings of fruit and vegetables per day indicating little has changed since 2006. In spite of this, vitamin C intakes were largely adequate as a result of whole breadfruit and pumpkin consumption.

Kiribati is not perceived to have chronic hunger or food insecurity,[26] but the preference for, and increasing dependence on, imported foreign food such as white rice, refined sugar and tinned meat raise issues for both current nutritional adequacy and future food and nutrition security. The heavy reliance on imported foods is likely to cause a gradual but progressive loss of local food production knowledge and capacity. This may be exacerbated by the impacts of climate change, which may include loss of productive land through higher sea levels, and soil erosion, tree damage and crop losses through a higher frequency of severe storm events.[27]

A high consumption of sugar and refined cereals, and low intake of fruits and vegetables, represents inadequacies in Kiribati diets. A common practice (noted in 24-hr dietary recall results) was to add sugar to nearly all meals. Many studies have indicated deleterious effects of added sugar to human health. As examples, added sugar was found to be correlated with increased risk of metabolic syndrome in adolescents in the National Health and Nutrition Examination Survey (NHANES) (even after controlling for total energy intake and the BMI z-scores)[28] and in other works has been linked to hypertension and elevated uric acid levels.[29,30] A global epidemiological econometric analysis revealed that changes in sugar

Table 2. Calculated daily nutrient intakes of the subjects (19- 65 years) based on 24-hour dietary recall data, and comparison to reference intakes (RNIs)

	Protein (mol/d)	Vit. B-1 (mg/d)	Vit. B-2 (mg/d)	Vit. B-3 (mg/d)	Vit. C (mg/d)	Vit. A (total µg/d)[†]	Sodium (mg/d)	Potassium (mg/d)	Magnesium (mg/d)	Calcium (mg/d)	Iron (mg/d)	Zinc (mg/d)
Men (N=43)												
Average	87.0	0.7	0.7	19	55	280	1920	1880	232	265	7	6.4
(SD)	(34.8)	(0.4)	(0.6)	(8)	(89)	(311)	(1210)	(1570)	(104)	(201)	(3)	(3)
RNI	84.8[‡]	1.2	1.3	16	45	600	920-460[‡]	3800[‡]	400	1000	8	14.0
(%) RNI	103	61.7	52.1	119	122	46.7	209-418	49.4	57.9	26.5	86.1	45.6
Women (N=118)												
Average	66.8	0.62	0.59	15.3	74.3	225	1450	1600	202	205	6.0	5.0
(SD)	(37.2)	(0.60)	(0.40)	(8.2)	(133)	(667)	(1075)	(1056)	(118)	(209)	(4.1)	(3.5)
RNI	47.5[‡]	1.10	1.10	14.0	45.0	600	460-920[‡]	2800[‡]	400	1000	18	8.0
(%) RNI	141	56.4	53.6	109	165	37.5	158-315	57.1	50.6	20.5	31.3	62.6

[†]Calculated as retinol equivalents (REs).
[‡]Values obtained from Nutrient Reference Values of Australia and New Zealand.

Table 3. Calculated daily nutrient intake of the male subjects compared with WHO/FAO requirements for different age groups/sex obtained using weighed food record.

	Protein (mol/d)	Vit. B-1 (mg/d)	Vit. B-2 (mg/d)	Vit. B-3 (mg/d)	Vit. C (mg/d)	Vit. A (total µg/d)[‡]	Sodium (mg/d)	Potassium (mg/d)	Magnesium (mg/d)	Calcium (mg/d)	Iron (mg/d)	Zinc (mg/d)
Male (1- 3 yrs)[2†]												
Average (SD)	52.8 (1)	0.9 (0.1)	0.7 (0.1)	11 (1)	49 (2)	165 (4)	1590 (14)	1100 (9)	205 (5)	287 (1)	7 (1)	5.9 (2)
RNI	12.0[§]	0.5	0.5	6	30	400	200-400[§]	2000[§]	60	500	4	4.1
(%) RNI	440	180	140	183	163	41.3	399-797	54.6	342	57.4	175	144
Male (4-6 years)[1]												
Average (SD)[¶]	80.4 (-)	0.6 (-)	0.8 (-)	12 (-)	44 (-)	71 (-)	2560 (-)	764 (-)	227 (-)	403 (-)	5.7 (-)	8.1 (-)
RNI	16.0[‡]	0.6	0.6	8	30	450	300-600[§]	2300[§]	73	600	4	5.1
(%) RNI	503	100	133	150	147	15.8	426-853	33.2	311	67.2	143	159
Male (7-9 years)[2†]												
Average (SD)	53.5 (0.5)	0.6 (0.0)	0.8 (0.1)	15 (2)	92 (2)	131 (4)	2070 (10)	1410 (11)	290 (6)	258 (4)	10 (1)	8.4 (1)
RNI	16.0[§]	0.9	0.9	12	35	500	300-600[§]	3000[§]	100	700	6	5.1
(%) RNI	334	66.7	88.9	125	263	26.2	344 -689	46.9	290	36.9	167	165
Adult (19-65 years)[10†]												
Average (SD)	92.8 (5)	1.1 (0.2)	0.8 (0.1)	18 (2)	49 (3)	71 (5)	3080 (15)	1220 (21)	301 (16)	331 (10)	10 (2)	7.8 (1)
RNI	84.4[§]	1.2	1.3	16	45	600	460-920[§]	3800[§]	260	1000	9	7
(%) RNI	110	91.7	61.5	113	109	11.8	335-670	32.1	116	33.1	111	111

[†]Number of subjects in each age category.
[‡]Calculated as retinol equivalents (REs).
[§]Values obtained from Nutrient Reference Values of Australia and New Zealand.
[¶]Values that do not have SD because it contains only one subject.

Table 4. Nutrient intake of the female subjects compared with WHO/FAO requirements for different age groups/sex obtained using weighed food record.

	Protein (mol/d)	Vit. B-1 (mg/d)	Vit. B-2 (mg/d)	Vit. B-3 (mg/d)	Vit. C (mg/d)	Vit. A (total µg/d)‡	Sodium (mg/d)	Potassium (mg/d)	Magnesium (mg/d)	Calcium (mg/d)	Iron (mg/d)	Zinc (mg/d)
Females (4-6 years)[1†]												
Average (SD)¶	48.7 (-)	0.4 (-)	0.4 (-)	9 (-)	1 (-)	37 (-)	1410 (-)	499 (-)	129 (-)	179 (-)	4 (-)	4.1 (-)
RNI	16.0§	0.6	0.6	8	30	450	300-600§	2300§	73	600	4	5.1
(%) RNI	304	66.7	66.7	112.5	3.3	8.2	235 -471	21.7	177	29.8	100	80.4
Female (10-18 years)[1†]												
Average (SD)¶	49.1 (-)	1.0 (-)	1.0 (-)	16 (-)	51 (-)	138 (-)	3150 (-)	1181 (-)	265 (-)	212 (-)	12 (-)	7.5 (-)
RNI	35.1§	1.10	1.00	16	40	600	400-800§	2600§	230	1300	21	7.8
(%) RNI	140	90.9	100	100	128	23.0	393-787	45.4	115	16.3	57.1	96.2
Adult (19-65 years)[12†]												
Average (SD)	69.5 (6.5)	0.8 (0.3)	0.6 (0.1)	13 (1)	25 (3)	76.6 (6)	2170 (21)	818 (10)	212 (5)	256 (7)	7 (1)	6.0 (2)
RNI	47.5§	1.1	1.0	14	45	500	460-920§	2800§	220	1000	20	4.9
(%) RNI	147	72.7	60.0	92.9	55.6	15.3	236 -472	29.2	96.4	25.6	35.0	122

†Number of subjects in each age category.
‡Calculated as retinol equivalents (REs).
§Values obtained from Nutrient Reference Values of Australia and New Zealand.
¶Values that do not have SD because it contains only one subject.

availability are predictive of changes in prevalence of diabetes, independent of poverty, physical activity, obesity, urbanization or ageing.[31] The low consumption of fruits and vegetables, as identified from the 24 hour dietary recall, have additional negative irreversible consequences. In particular, many studies indicate that fruits and vegetables eaten as part of the daily diet can decrease the risk of coronary heart disease,[32] stroke[33] and some cancers.[34] Increased consumption of refined rice and flour based dishes among the studied population is of concern. These foods are imported and subsidised by the government, unlike their more nutritious counterparts, i.e. fruit and vegetables. 'Modern' dietary patterns, portrayed by high consumption of foods such as potato chips, cake, rice, instant noodles, and low intakes of indigenous traditional diets, have been shown to be associated with an increased prevalence of metabolic syndrome.[35] In contrast, 'traditional' Pacific Island dietary patterns, high in fresh fish and seafood, as well as other local foods, such as coconut-based dishes, taro and papaya, have been associated with reduced prevalence of metabolic syndrome, increased HDL cholesterol and reduced waist circumference.[35] A heavy dependence on poor-quality imported foods is aggravating the perceived genetic predisposition of people in Pacific Island countries to obesity.[36]

Low DD in 61% of the households is of concern. Low DD has been associated with increased prevalence of NCDs. Possible reasons include increasingly limited access to a diverse traditional food supply, and/or poor nutritional knowledge and/or a personal preference toward unbalanced dietary practices.[37] It would also affect the gut microbiome, which in turn may have profound effects on the immune system and resulting NCDs. Our study shows that low energy and protein intakes are not nutritional problems in South Tarawa, Kiribati. Instead, attention should be given to the inadequate intakes of micronutrients such as magnesium, potassium, calcium and vitamin A as observed in both the 24 hour dietary recall and weighed food record. Sodium intakes for all age groups in both males and females was significantly higher than their requirements and requires attention.[38] Debate has emerged about the level of dietary sodium intake that is associated with risk of adverse outcomes. Some questions about whether the reference figures may have been set too low – given that 95% of the world may exceed them, and sodium is homeostatically regulated.[39] An Institute of Medicine Panel on dietary Reference Intakes has been charged to review the recommended intakes for all population for sodium.[40] Reduced salt intake and increased consumption of fruits and vegetables have been associated with beneficial effects in lowering blood pressure,[41] atherosclerosis,[42] type 2 diabetes[43] and oxidative damage to cells.[44] The consequences of micronutrient malnutrition could take a long time to manifest, but effects can be irreversible. An intergenerational cycle of malnutrition could occur if adequate measures are not implemented. At a cellular level, these include altered epigenetic characteristics. Each of these changes can lead to adult cardiovascular disease, or render the individual more susceptible to the effects of environmental stressors such as obesity arising in later life, placing a substantial health and economic burden on both the government and the people.[45]

The limitations of our study were that dietary data were collected for only one recall period, in one season and at a time of plenty. However, in theory this should have resulted in increased dietary diversity, as more foods are available to select from. This implies that the results of this work may in fact underestimate the problem.

In conclusion, this paper has attempted to assess information on nutrition/dietary characteristics of households in South Tarawa, Kiribati. Specifically, it provides baseline values for indicators in a wide range of areas including food security (dietary diversity), and nutrition (nutrient intake).

AUTHOR DISCLOSURES

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