Original Article

Limits to commercially iodized salt to address dietary iodine deficiency in rural Papua New Guinea

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Background and Objectives: Fortifying commercial table salt with iodine is the principal strategy used globally to prevent dietary iodine deficiency. However, the costs of providing fortified salt to remote communities may result in it not being locally available or too expensive for many households. This study shows that barriers to consuming adequately iodized salt remain significant for remote rural households in Papua New Guinea (PNG). **Methods and Study Design:** Using data from a rural household survey conducted in four areas of PNG in 2018, two issues are examined. First, we contrast the characteristics of households that reported consuming or not consuming iodized table salt, respectively. Second, the adequacy of the iodine content of samples of table salt consumed was assessed in the laboratory. **Results:** Nine percent of the 1,026 survey households reported not consuming iodized table salt. These households tend to live in remote communities, are among the poorest households, have received no formal education, and have experienced recent food insecurity. Second, 17 percent of the 778 salt samples tested had inadequate iodine. The brand of salt most commonly consumed had the highest share of samples with inadequate iodine levels. **Conclusions:** Particularly in remote communities, ensuring that individuals consume sufficient iodine will require going beyond salt iodization to use other approaches to iodine supplementation. To ensure that the iodine intake of those using commercial table salt is adequate, closer monitoring of the iodine content in table salt produced or imported into PNG and enforcement of salt iodization regulations is required.

Key Words: iodine deficiency, commercial food fortification, Papua New Guinea, iodized salt, nutrient fortification standards

INTRODUCTION

Iodine, together with vitamin A, iron, and zinc, is one of the four principal dietary micronutrients for which deficiencies are of public health concern globally. Iodine, although only needed by the body in minute amounts, is critical to the production by the thyroid gland of the hormones thyroxine and triiodothyronine that regulate many growth functions and metabolic activities of the body.[1] A deficiency of iodine in the diet will result in the thyroid not being able to make the hormones. The most severe consequence of iodine deficiency is stunted physical and mental growth in children that results in significant and generally irreversible intellectual disability. This disorder often stems from iodine deficiency during pregnancy. In addition to affecting fetal growth, maternal iodine deficiency may result in miscarriages and stillbirths. Goiter, an enlargement of the thyroid at the base of the neck, is also commonly seen in individuals who do not consume sufficient iodine.

The underlying cause of iodine deficiency is a scarcity of iodine in the soil on which vegetation grows, animals graze, and crops are cultivated. This results in insufficient iodine in the foodstuffs produced.[2] In contrast, ocean-sourced foods typically contain relatively high levels of iodine.[3] Fortifying commercial table salt with sufficient iodine to meet dietary needs as the salt is being produced is the principal strategy used globally to prevent iodine deficiency and its adverse health and developmental impacts. Salt is an appropriate vehicle for fortification because it is consumed by virtually everyone almost every day with little seasonal variation, salt production in most countries is quite centralized, adding iodine does not affect the taste or smell of the salt, and fortifying salt with

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iodine is inexpensive – USD 0.02 to 0.05 per individual per year.[3]

Iodine deficiency is a long recognized and ongoing nutritional challenge in Papua New Guinea (PNG). Some of the earliest work globally on the use of iodized oil to address iodine deficiency was carried out in PNG in the 1950s and 1960s.[4] The nationally representative 2005 National Nutrition Survey found that iodine consumption is generally adequate for non-pregnant women of childbearing age in PNG – only about 30 percent had urinary iodine levels below the critical threshold of 100 µg/L.[5] The 2005 survey results also showed that the median urinary iodine level of women in households without iodized table salt (79.5 µg/L) was much lower than that of women in households with such salt (182.5 µg/L). More recent community-level studies show that a majority of school-age children and non-pregnant women of childbearing age have at least moderate iodine deficiency.[6,7]

Universal salt iodization became required by law in PNG with the passage of legislation in 1995. All table salt must have at manufacture or at importation into PNG an iodine content of between 40 and 70 parts per million (ppm).[8] The regulations associated with this legislation assume a 30 percent loss in iodine before consumption.[9] Hence, to be within regulations, the iodine content of table salt in the household should be between 30 and 50 ppm.[6]

However, many rural communities in PNG are found in remote locations with little access to commercially produced goods, like iodized salt. Moreover, in such isolated communities, education levels are relatively low and access to information on the components of nutritious diets or on other nutrition-caring practices is difficult to obtain. Consequently, there are important barriers to consuming adequately iodized salt for many remote PNG households.

Using data from a 2018 survey of over 1,000 households in four rural areas of lowland PNG, we examine two issues related to salt iodization in PNG:

-The consumption of packaged table salt by rural households to assess how effective universal commercial salt iodization is likely to be in meeting the iodine requirements of all individuals; and

-Whether the iodine content of the table salt that survey households consume is within the standards of the salt iodization regulations of PNG.

In contrast to more comprehensive studies on the impact of iodized salt consumption on the prevalence of iodine deficiency disorders, no information was collected in the survey on precise levels of individual consumption of iodized salt or on urinary iodine concentration.[6,7] Nonetheless, the challenges in supplying iodized salt to rural households identified through this research can guide efforts to refine both salt iodization strategies and public health outreach to address iodine deficiency in PNG.

METHODS

Study site and population

Between May and July 2018, the Papua New Guinea

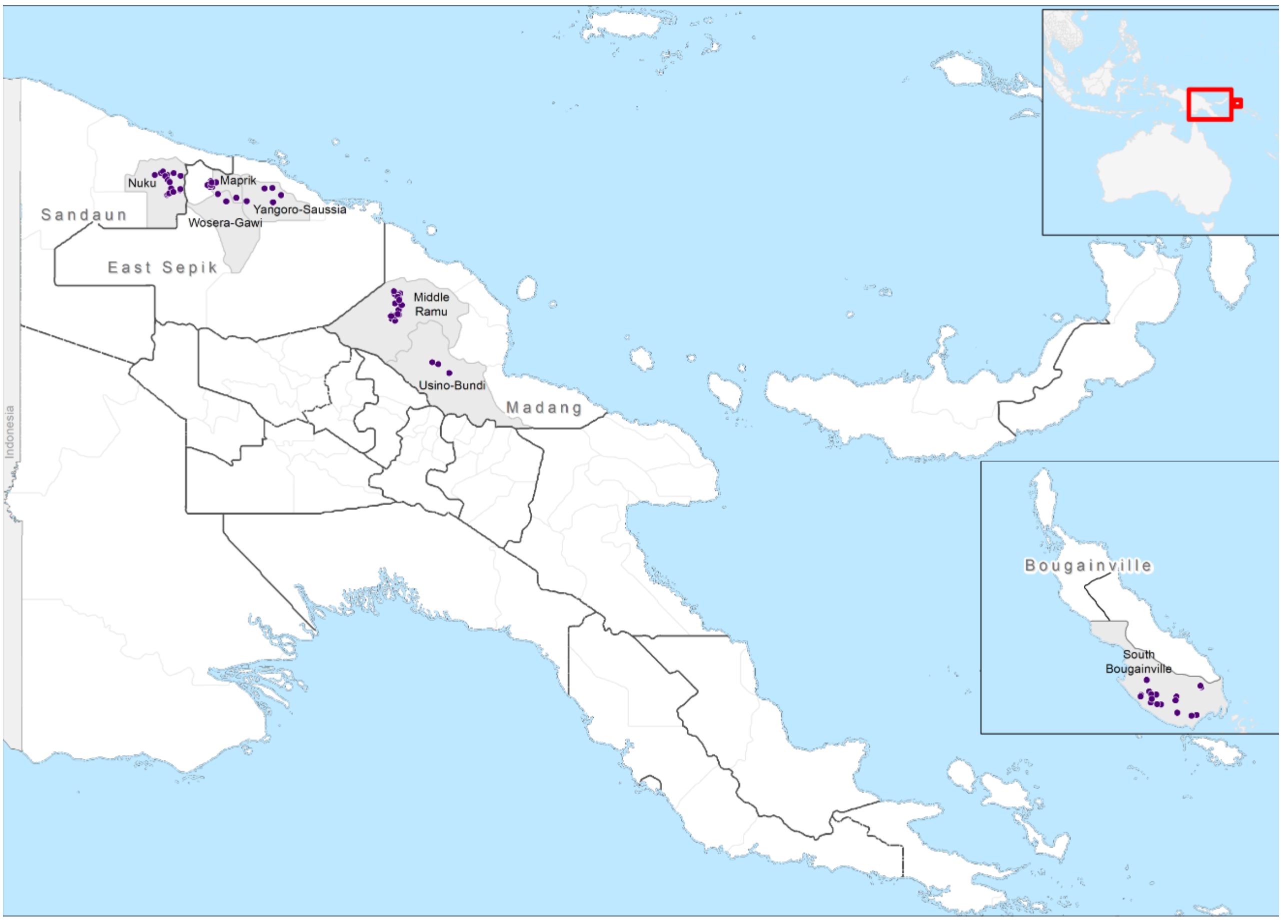

Figure 1. Location of survey communities – Papua New Guinea Household Survey on Food Systems, 2018.[10]

Household Survey on Food Systems was implemented in four rural areas of PNG (Figure 1):

- Autonomous Region (AR) of Bougainville – in South Bougainville district in the Siwai and Buin areas at the southern end of the island,
- Madang province – in parts of Middle Ramu and Usino-Bundi districts, a remote area on the Ramu River only accessible by boat,
- East Sepik province – in districts near Maprik town and along the main road from Wewak, and
- West Sepik (Sandaun) province – in Nuku district.

The design of the survey involved interviewing 15 randomly selected households in 70 communities selected for enumeration across the four study areas – between 16 and 20 communities in each study area. The final survey sample consists of 1,026 households.[11]

Given the challenges of conducting a representative survey in rural PNG, the survey information collected is not representative at the provincial or district level. Households in communities in the most remote areas of the districts in which the survey was conducted were not part of the survey population. Consequently, the analysis here does not necessarily reflect the characteristics of the broader population of any administrative units in which the survey households are found. Nonetheless, the data provide insights into the nutritional challenges facing rural households across a spatially expansive set of rural communities in PNG.

The survey investigated the food systems of the sample households and how they assure sufficient food to meet the nutritional needs of their household members. The household questionnaire included modules on production; consumption and expenditure, including details on foods consumed over the past seven days; labor activities (farm and non-farm); nutritional status; and the experience of the survey households with recent agricultural production or other shocks that impacted their livelihoods.

As an additional component of the nutritional investigations under the survey, all households that reported having consumed table salt as part of their meals in the previous seven days were asked to provide a sample of about one teaspoon of that salt. A photograph was taken of the household salt container and, if possible, the branded packet in which the salt was obtained (Figure 2). The brand name for the salt also was recorded by the survey enumerator. The salt sample, packaged in an individually labeled small polyethylene bag, was sent to the Micronutrient Research Laboratory at the School of Medicine and Health Sciences of the University of Papua New Guinea in Port Moresby for iodine content analysis.

The iodine content in the salt samples was measured using a WYD Iodine Checker, which quantitatively measures the iodine content in a substance on the basis of a single wave length photometer. Globally, the instrument has been shown to provide accurate and reliable results for monitoring iodine concentration in salt.[12] The amount of salt used per assay was 1.0 g. Two assays were made on each sample with the average of the two results used in the analysis. The intra-assay percent coefficient of variation for all samples tested was 0.9 percent. A set of rules were established for internal bench quality control for all samples analyzed. Calibration and daily monitoring of the performance characteristics of the WYD Iodine Checker was done using distilled water and a grey glass control provided by the instrument manufacturer that has stable absorbance characteristics.[13] Iodine concentrations in the table salt samples were expressed in parts per million (ppm).

RESULTS

Two analytical results are reported here. First, we examine table salt consumption patterns among survey households. Second, for those survey households that provided a salt sample, we assess whether the iodine content in that sample meets the salt iodization standards for PNG.

Table salt consumption by survey households

The survey questionnaire included a detailed food consumption module to ask survey respondents whether their household consumed any of 37 separate food items over the previous seven days. Included in the list of food items is "Packaged salt for table & kitchen". The responses to this question are presented in Figure 3 disaggregated by different categories of survey households. Traditionally produced salt was not considered in the food consumption module of the survey questionnaire.

Overall, only 91 of the 1,026 survey households (8.9 percent) reported not having consumed packaged table salt in the seven days prior to the day of their being interviewed. However, survey households in Madang province and those that are located more than four hours travel time from the nearest large town are more likely to not have consumed packaged table salt. (Travel time to nearest town was computed using a Geographic Information System that takes into account the location of the surveyed communities and local major town, land cover and topography, and transportation routes, both roads and rivers.) The survey in Madang province was conducted in

Figure 2. Examples of containers and branded packets from which salt samples were obtained from survey households.[10]

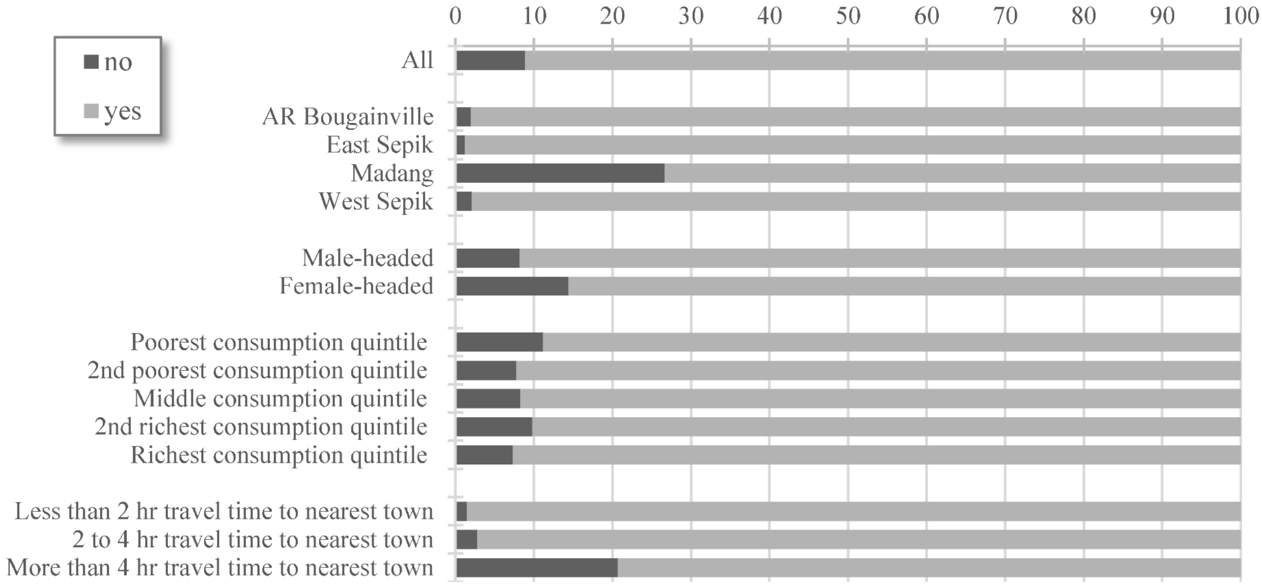

Figure 3. Consumption of packaged salt for table & kitchen in past seven days, percent of survey households.[10]

remote Middle Ramu district. We also see that households headed by women are less likely to have consumed table salt. While a greater share of households in the poorest consumption quintile reported not consuming table salt in the past seven days than households in other consumption quintiles, the differences between consumption quintiles are not statistically significant.

To better understand the household characteristics that are associated with a household not consuming table salt in the past seven day within a multivariate analytical framework, Table 1 presents the results of a logistic regression analysis for which the dependent variable is whether the survey household did not consume table salt in the previous seven days and the explanatory variables are a range of household characteristics. The coefficients for each explanatory variable are presented as odds-ratios. Of the 20 household characteristics considered, only six are shown to be significantly associated whether a house-

Table 1. Logistic regression analysis of whether a household did not consume table salt in the past seven days

Dependent variable: Household did not consume table salt in past seven days, 0/1	Odds-ratio	*p* value
Female headed households, 0/1	1.215	0.618
Household head age under 25 years, 0/1	1.261	0.730
Household head age 25 to 35 years, 0/1	1.403	0.285
Household head age 65 years or older, 0/1	0.685	0.498
Poorest consumption quintile, 0/1	1.997	0.079*
2nd poorest consumption quintile, 0/1	0.989	0.978
2nd richest consumption quintile, 0/1	1.247	0.574
Richest consumption quintile, 0/1	1.211	0.653
Household size, number	1.013	0.848
No formal education for any household member head, 0/1	3.878	0.048**
Secondary or tertiary education highest educational attainment in household, 0/1	0.441	0.002***
Non-farm activity is household head's primary occupation, 0/1	0.672	0.285
Household members engage in wage employment, 0/1	1.427	0.464
Household members engage in non-farm enterprise, 0/1	0.695	0.182
Household members include a current migrant (still considered part of household), 0/1	0.935	0.845
Household Dietary Diversity Score, foods consumed in past 24 hours out of 16 food groups	0.882	0.073*
Worried about household food insecurity in past 4 weeks, 0/1	2.785	0.000***
Household with child under five years of age, 0/1	0.774	0.436
2 to 4 hours travel time to nearest town, 0/1	2.329	0.144
More than 4 hours travel time to nearest town, 0/1	16.043	0.000***
Constant	0.022	0.000***
Observations: 1,026; Pseudo R-squared: 0.265		

Source: Analysis of data from the PNG Household Survey on Food Systems, 2018.[10]
*p<0.10, **p<0.05, ***p<0.01.
Base explanatory variable categories: Age of household head: age 36 to 64 years; Consumption quintile: middle (third) quintile; Maximum educational attainment in household: primary education; and Travel time to nearest town: less than 2 hours.

hold does not consume table salt. Factors positively associated with a household not having consumed table salt in the past week include being in the poorest consumption quintile, having no members who completed any schooling, having recently experienced food insecurity, and being a resident of the most remote communities surveyed. Being a female-headed household is not one of these characteristics, however, despite the pattern seen in Figure 3. In contrast, households with at least one member who received some secondary education and those with higher diversity in their diets are less likely to not consume table salt (statistically significant odds-ratio less than 1.0). Of these drivers of table salt consumption, the remote location of the household likely is the most important, as opportunities for education, improved livelihoods (as measured by the value of household consumption), and expanded dietary resources, the other characteristics associated with not consuming table salt, tend to be constrained in more remote areas.

Iodine content in salt samples obtained from survey households

If a survey household reported that they consumed table salt in the previous seven days, the respondent was asked to provide a small sample of the salt for testing of its iodine content. However, not all households were able or were willing to provide a sample, even though they reported having consumed table salt. In addition, in transferring the salt samples from the field to the laboratory in Port Moresby, some were misplaced and lost. Table 2 shows the number of households that fall into the different categories based on their provision of and the testing of a table salt sample.

Table 3 summarizes the results of the iodine testing of the 778 table salt samples obtained from survey households that were then successfully analyzed in the Micronutrient Research Laboratory in Port Moresby, disaggregated by the four study areas and by travel time to the nearest large town. The results generally are encouraging. Almost two-thirds of the salt samples fall within the expectations at household level of the PNG salt iodization regulations of the iodine content being between 30 and 50 ppm.

One-fifth of the samples have an iodine content above 50 ppm and can be categorized as having an excessive level of the micronutrient. One-sixth of the samples were found to have iodine levels below 30 ppm, the lower end of the acceptable range under the PNG salt iodization regulations. Disaggregating the laboratory results by the four study areas or by distance to the nearest large town, as shown in Table 3, does not provide much insight into what might account for these table salt samples with iodine content outside of the acceptable range.

To better understand what might account for samples containing either inadequate or excessive levels of iodine, we use a multinomial logit regression analysis at house-

Table 2. Table salt samples from survey households – provision of sample and testing of it, percent of households

Household category by salt sample provision	All	AR Bougainville	East Sepik	Madang	West Sepik
No packaged table salt consumed in past 7 days (n=91)	8.9	2.0	1.2	26.7	2.1
Consumed salt, but no salt in household now for sample (46)	4.5	2.8	1.6	10.3	2.1
Consumed salt, but no sample provided (54)	5.3	9.6	2.4	6.2	2.5
Salt sample provided and analyzed (778)	75.9	82.5	90.6	52.4	82.3
Salt sample provided, but lost in transit to laboratory (57)	5.6	3.2	4.1	4.4	10.9
Households	1,026	251	245	292	238

Source: Analysis of data from the PNG Household Survey on Food Systems, 2018.[10]

Table 3. Iodine content in table salt samples obtained from survey households

	All	Study area				Travel time to town		
		AR Bougainville	East Sepik	Madang	West Sepik	< 2 hrs	2-4 hrs	> 4 hrs
Iodine content, ppm								
Mean	41.4	41.4	43.4	45.4	35.8	40.5	39.8	44.1
Standard deviation	14.6	16.8	12.3	15.9	11.5	12.1	16.4	16.0
Median	39.1	37.1	41.6	41.0	35.4	39.6	35.8	40.1
Minimum	2.5	6.5	11.8	2.5	4.0	4.0	8.1	2.5
Maximum	116.4	116.4	108.7	95.8	82.3	84.3	116.4	95.8
Iodization standards for Papua New Guinea, % of samples								
Inadequate, less than 30 ppm	16.4	23.7	6.8	10.5	24.5	12.3	25.6	14.3
Adequate, 30 to 50 ppm	63.0	50.7	72.1	60.1	67.9	71.8	54.1	57.8
Excessive, more than 50 ppm	20.6	25.6	21.2	29.4	7.6	15.8	20.3	27.8
Household provided a sample, % of all survey households	75.9	82.5	90.6	52.7	82.3	84.8	83.8	61.0
Households provided sample, no.	778	207	222	153	196	341	207	230
All survey households, no.	1,026	251	245	292	238	402	247	377

ppm: parts per million.
Source: Analysis by the Micronutrient Research Laboratory, Port Moresby, of table salt samples obtained from survey households for the Papua New Guinea Household Survey on Food Systems, 2018.[10]

hold level. The base category for this analysis is households who provided samples with an iodine content that are within the expectations at household level of the PNG salt iodization regulations of between 30 and 50 ppm. The results are shown in Table 4.

Limited additional insights are gained from the multinomial logit regression analysis of iodine levels in the table salt samples obtained from survey households. Most of the explanatory variables with a significant relative risk ratio for one category do not show a consistent pattern with the results on that variable for the other category. For example, we find that table salt both with inadequate amounts of iodine and with excessive amounts is more likely to be consumed by households in more remote communities, particularly those that are located 2 to 4 hours from the nearest town. It is difficult to develop a plausible explanation for these and for other variables with significant results. We conclude that it is unlikely that any household characteristics are closely associated with whether the table salt the household consumes has either inadequate or excessive amounts of iodine.

A more important factor is likely the manufacturer of the iodized salt. The brand name of the salt was recorded for all of the samples obtained. Six table salt brands made up 94.5 percent of the 778 samples obtained, with one of the brands accounting for over half of all samples. The adequacy of the iodine content of the table salt samples by brand is presented in Table 5.

As different brands of table salt are found in different study areas, the iodine content of the particular brand of table salt may be an important factor in accounting for the different levels of adequacy in iodine content seen in each study area (see Table 3). The most common brand used by survey households in southern Bougainville generally contains excessive amounts of iodine. High levels of iodine are also seen in one of the common brands used in Madang. The most common brand used by all survey households, Brand 3, has the largest share of samples with inadequate amounts of iodine. These results suggest that continual monitoring of the iodine content of salt produced in PNG or imported into the country is required by the regulatory authorities to ensure that the salt meets the standards.

DISCUSSION

There are two main policy implications that can be drawn from this research. First, although most do, there remain a sizeable number of Papua New Guineans who do not consume packaged table salt. These individuals, commonly living in remote rural communities, are likely to be at significantly higher risk of the negative growth and health ramifications of iodine deficiency than the broader population of the country. The limited commercial networks in remote areas of PNG generally will not supply packaged table salt to households living in those areas. These remote households, if they use any salt on their food at all, will primarily rely on that which they produce themselves using local salt sources and traditional methods. Such salt, of course, is not iodized.

For households living in remote communities, ensuring that they consume sufficient iodine will require more than requiring that all packaged table salt in PNG meet certain iodine content levels. Even though packaged table salt is among the handful of commercial products – alongside matches, soap, batteries, rice, sugar, tinned fish, and tinned meat – that may be found in rural shops (Figure 4), there remain many communities in which such shops are not present or in which many community members will have insufficient cash income to obtain goods from such shops, even if they are present in their community.

For these remote communities, continued efforts are needed to deepen their engagement with markets to ensure that all are utilizing iodized table salt. However, while salt iodization should be the long-term objective for addressing iodine deficiency in PNG, such an approach, as the survey data analysis here shows, is not yet able to reliably reach all citizens of the country. From a public health perspective, meeting the dietary iodine requirements of residents of remote communities will involve going beyond universal salt iodization. Specific public health outreach efforts to ensure that such individuals are consuming enough iodine will be needed. If biomedical studies assessing urinary iodine concentrations or other measures of iodine levels confirm that the iodine status of individuals in such communities is deficient, iodized oil, either as injections or orally, or alternative clinical approaches for iodine supplementation could be administered as part of public health campaigns, such as, for example, around vaccinations.[14] Alternatively, subsidizing or otherwise providing incentives to traders to provide iodized table salt for sale in remote communities at prices affordable to their residents also could improve access the micronutrient. Only in such ways can the iodine requirements for all those in PNG who have insufficient iodine in their diet be met and the significant physical and cognitive growth and development burdens caused by iodine deficiency be lifted across the country.

Second, for those Papua New Guineans who consume packaged table salt, universal salt iodization is an effective means to supply them with dietary iodine for the prevention of iodine deficiency disorders. The analysis of the iodine content of the table salt samples collected from the 2018 rural survey households showed that most samples met the PNG regulations for salt iodization.

On average, only one out of six samples had iodine levels below the acceptable range. However, when the samples were examined based on brand name, it was

Figure 4. Goods on sale, including table salt in bags at left center, in village shop in southern AR Bougainville, 2017.[10]

Table 4. Household characteristics associated with survey household having provided a table salt sample with either inadequate or excessive levels of iodine, multinomial logit regression analysis, relative risk ratios

	Inadequate iodine, less than 30 ppm		Excessive iodine, more than 50 ppm	
	Relative risk ratio	*p*-value	Relative risk ratio	*p*-value
Female headed households, 0/1	1.437	0.315	1.360	0.363
Household head age under 25 years, 0/1	0.197	0.139	0.765	0.666
Household head age 25 to 35 years, 0/1	1.184	0.504	0.977	0.924
Household head age 65 years or older, 0/1	0.890	0.790	1.047	0.905
Poorest consumption quintile, 0/1	1.758	0.086 *	0.676	0.238
2nd poorest consumption quintile, 0/1	1.105	0.766	1.227	0.475
2nd richest consumption quintile, 0/1	0.792	0.486	0.831	0.524
Richest consumption quintile, 0/1	0.709	0.330	1.280	0.410
Household size, number	0.869	0.017 **	0.988	0.812
No formal education for any household member, 0/1	3.047	0.261	0.000	0.985
Secondary or tertiary education highest educational attainment in household, 0/1	0.858	0.564	1.507	0.121
Non-farm activity head's primary occupation, 0/1	1.248	0.359	0.469	0.003 ***
Household members engage in wage employment, 0/1	0.536	0.155	1.053	0.870
Household members engage in non-farm enterprise, 0/1	1.296	0.243	1.025	0.904
Household members include a current migrant (still considered part of household), 0/1	1.002	0.995	1.221	0.412
Household Dietary Diversity Score, foods consumed in past 24 hours of 16 food groups	1.167	0.000 ***	0.986	0.729
Worried about household food insecurity past 4 weeks, 0/1	1.039	0.864	0.710	0.094 *
Household with child under five years of age, 0/1	1.214	0.441	0.820	0.366
2 to 4 hours travel time to nearest town, 0/1	2.205	0.002 ***	1.726	0.029 **
More than 4 hrs. travel time to nearest town, 0/1	1.372	0.244	2.226	0.000 ***
Constant	0.144	0.000 ***	0.257	0.007 ***
Observations	128		160	
Total observations: 778; Pseudo R-squared: 0.067				

Source: Analysis of data from the Micronutrient Research Laboratory, Port Moresby, of table salt samples obtained from survey households for the Papua New Guinea Household Survey on Food Systems, 2018.[10]
*p<0.10, **p<0.05, ***p<0.01. ppm: parts per million.
Base table salt sample category: Households for which sample had "Adequate iodine, 30 to 50 ppm".
Base explanatory variable categories: Age of household head: household head age 36 to 64 years; Consumption quintile: middle (third) quintile; Maximum educational attainment in household: primary education; and Travel time to nearest town: less than 2 hours.

Table 5. Brands of table salt samples and iodine content, percent of samples

Table salt brand	Share,%	Row total, %			Principal study areas in which brand is found
		Inadequate	Adequate	Excessive	
Brand 1	7.7	8.3	70.0	21.7	East Sepik; West Sepik
Brand 2	7.2	5.4	26.8	67.9	AR Bougainville
Brand 3	50.9	22.5	66.7	10.9	All, except Madang
Brand 4	6.9	9.3	66.7	24.1	All, except AR Bougainville
Brand 5	13.5	12.4	74.3	13.3	Madang
Brand 6	8.2	7.8	45.3	46.9	Madang
Other	5.5	18.6	60.5	20.9	Madang
TOTAL	100.0	16.4	63.0	20.6	--

Source: Analysis of data from the Papua New Guinea Household Survey on Food Systems, 2018.[10]
Note: Total samples: 778. Iodine content is evaluated using the PNG iodization standards: "Inadequate" is less than 30 parts per million (ppm); "Adequate" is 30 to 50 ppm, and "Excessive" is more than 50 ppm.

found that samples with inadequate amounts of iodine were most prevalent for the most commonly consumed brand of table salt. The incidence of iodine deficiency disorders will increase if significant amounts of packaged table salt with an inadequate amount of iodine are allowed to be sold across PNG.

Table salt with iodine levels above the recommended range – excessive iodine – will require a more detailed understanding of iodized salt consumption by individuals than is possible to attain from the 2018 survey. Excessive consumption of iodine can result in hyperthyroidism, although most individuals tolerate high dietary intakes of iodine.[1] Moreover, only two of the 778 table salt samples collected in the survey had iodine levels more than twice the recommended maximum level of 50 ppm. Given that table salt consumption levels generally are quite low in most areas of rural PNG, the current prevalence of excessive iodine in iodized table salt is unlikely to be a pressing public health concern.

Closer monitoring of the iodine content in table salt produced or imported into PNG and enforcement of salt iodization regulations is required. Iodine losses from iodized salt can occur after production due to the manner in which the salt was iodized, deficiencies in packaging, and how the salt is stored.[3] Nonetheless, despite these post-production iodine losses, salt producers and importers need to be certain that the iodine levels in the salt they sell in PNG meets national standards before it is distributed to shops and markets across the country.

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The design of the household survey on which the research described in this article is based was approved (Approval #: DSG-18-0312) on 26 March 2018 by the Institutional Review Board of the International Food Policy Research Institute (IRB #00007490; FWA #00005121). All potential survey respondents were informed of the purpose of the survey and asked to give their consent to being interviewed before any questionnaire was administered to them.

AUTHOR DISCLOSURES

The authors declare no conflicts of interest

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