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SECOND REPORT:

**RESULTS FOR QUANTITATIVE ASSAY OF IODINE CONTENT IN SALT
SAMPLES COLLECTED FROM HOUSEHOLDS DURING DHS 2017/2018**

INTRODUCTION: [Please see the first report.](#)

METHODOLOGY:

Two separate batches of salt samples (collected in the DHS survey) were delivered to the Micronutrient Research Laboratory (MRL) in the Division of Basic Medical Sciences (BMS) School of Medicine and Health Sciences (SMHS) University of Papua New Guinea (UPNG).

In the MRL, the information on the enclosed sheets of paper in each of the boxes and the large zip-locked polythene bags containing a number of smaller zip-locked bags with salt samples, were checked and recorded. The names and number of clusters, including the identification number (ID#) on the label on each of the smaller zip-locked polythene bags with salt samples, were also recorded. Based on the recorded information, the salt samples were collected from households in 21 of the 22 provinces in PNG; the two boxes contained no salt from Southern Highlands Province (SHP). The boxes with the salt samples were stored in a cool room until required for analysis.

A quantitative assay of iodine content in each salt sample was carried out, using the WYD Iodine Checker, which is specifically used to measure the concentration of iodine in iodized salt. The concentration (content) of iodine is expressed in **parts per million (ppm)** which is equivalent to one **mg of iodine per kilogram of salt (mg/kg)** {mg/kg = ppm}. The WYD Iodine checker measures the concentration of iodine in salt iodized with either **Potassium Iodate or Potassium Iodide** [1].

The amount of salt used per assay was 1.0g. Proportional amounts of reagents were used for the assay of 0.5g of salt.

Calibration of the WYD Iodine checker:

The iodine working standard solution supplied by the manufacturer was used routinely to calibrate the WYD iodine checker used for the analysis. After calibration of the WYD checker, the special Grey Glass supplied with the WYD checker was used routinely as the internal QC.

Internal Quality Control (QC) monitoring:

The internal (bench) QC used for the analysis was the “Westgard” QC system and “Westgard” QC rules. QC Pool Tracking Levy-Jennings Chart, prepared using the Grey Glass, was used for daily routine monitoring of the performance characteristics of the WYD checker. The intra-assay percent coefficient of variation (CV) was 0.9%. The Grey Glass Levy-Jennings Charts used in the analysis can be made available, if requested.

Criteria for Interpretation of the results on salt iodization:

The criteria used for interpretation of the salt iodine results were based on the PNG salt legislation [2, 3]. According to the legislation all salt must be iodised with potassium Iodate; the amount of iodine in table salt should be 40.0 to 70.0mg/kg (ppm); the amount of iodine in other salt should be 30.0 to 50.0mg/kg. These levels of iodine should be present at production or at the point of import.

WHO recommendations for iodine levels of food grade salt aim to provide 150µg iodine per day, assume 92% bioavailability, 30% losses from production to household level before consumption [4, 5].

If 30% of iodine is lost from salt iodised as per PNG salt legislation, iodine content of table salt at household level should be between 28.0mg/kg (40mg/kg minus 30%) and 49.0mg/kg (70mg/kg minus 30%). This implies that in PNG the iodine content in salt in retail outlets or at the time of consumption should be between 28.0mg/kg and 49.0mg/kg. Some recent publications on salt iodisation in PNG have rounded up the cut-off points by using “30.0 to 50.0mg/kg”. In this report, for the purpose of comparison the rounded up cut-off points (30.0 to 50.0mg/kg) have been used for presentation of the results. Salt with iodine levels of less than 5.0mg per kg is considered non-iodised salt [6].

The format (Table 1) recommended in the recent UNICEF guidelines [6] for the presentation of results on the monitoring of salt iodization programs is used in this report.

RESULTS & COMMENTS:

Information obtained from zip-locked bags:

The results presented below are based on the limited information obtained from the labels on both the large brown envelopes and the smaller zip-locked bags contained in the boxes. Appropriate corrections / modifications of the names can be made, since some of the labels were illegible.

The salt samples were from 21 provinces as presented in Table 1. The total number of salt samples received was 5442. The amount of salt in 14 of the zip-locked bags was less than 0.25g, thus it was recorded as “insufficient”. The number of insufficient salt samples was from the following provinces:

- Province # 002: Gulf: 3 salt samples
- Province # 003: Central: 1 salt sample
- Province # 004: NCD: 5 salt samples
- Province # 005: MBP: 1 salt sample
- Province # 011: EHP: 1 salt sample
- Province # 012: Morobe: 1 salt sample
- Province # 017: NIP: 2 salt samples

Table 1 shows the codes and names of the provinces and the total number of salt samples analyzed.

The detailed information obtained from the label on each zip-locked bag from each of the 21 provinces is presented in the attached spreadsheet. The information includes the following: **Province code; Cluster #, Household #, District #, LLG #, Ward #. Census unit & Salt brand.**

The corresponding iodine content (Mean \pm standard deviation) in the salt from each of the households is also presented in the spreadsheet.

It is assumed that the number of salt samples from each of the provinces should be equal to the number of Households in each of the provinces from which salt was collected. Each salt sample was analyzed in duplicate. The amount of salt in 85% of the zip-locked bags with salt was enough for two duplicate analyses to be done. Thus, 4 results were obtained, from which the mean and standard deviation were calculated.

It is important to note that the information given to our laboratory did not include the number of households with no salt on the day of sample collection. Thus, the information is not included in Table 1.

Table 1: Household iodized salt coverage by provinces: Results of iodine content in salt from households in the various provinces.

			Among HH with salt, the percentage (n) of salt with iodine content						
			Rounded-up cut-off points in PNG Salt Legislation						
Codes for provinces	Names of Provinces	Number of salt	<5.0 mg/kg	Inadequate: 5 – 29.9 mg/kg	Adequate: 30 – 50 mg/kg	Excess: > 50 mg/kg	Median (mg/kg)	<15 mg/kg	
# 001	WP	198	6.1% (12)	35.9% (71)	29.3% (58)	28.8% (57)	34.3	10.6% (21)	
# 002	Gulf	134	0.7% (1)	23.1% (31)	45.5% (61)	30.6% (41)	39.0	4.5% (6)	
# 003	Central	265	2.3% (6)	17.4% (46)	40.0% (106)	40.4% (107)	44.5	4.5% (12)	
# 004	NCD	469	6.8% (32)	16.4% (77)	33.3% (156)	43.5% (204)	48.3	11.5% (54)	
# 005	MBP	342	3.2% (11)	33.6% (115)	36.8% (126)	26.3% (90)	36.0	7.9% (27)	
# 006	Oro (NP)	161	19.9% (32)	35.4% (57)	32.9% (53)	11.8% (19)	31.6	28.6% (46)	
# 007	SHP	--							
# 008	Enga	212	4.2% (9)	12.7% (27)	60.4% (128)	22.6% (48)	40.4	6.1% (13)	
# 009	WHP	141	2.1% (3)	21.3% (30)	35.5% (50)	41.1% (58)	40.9	3.5% (5)	
# 010	Chimbu	114	2.6% (3)	25.4% (29)	64.9% (74)	7.0% (8)	35.5	7.0% (8)	
# 011	EHP	163	1.2% (2)	16.0% (26)	59.5% (97)	23.3% (38)	39.0	2.5% (4)	
# 012	Morobe	314	1.9% (6)	9.9% (31)	61.5% (193)	26.8% (84)	40.9	3.2% (10)	
# 013	Madang	391	13.0% (51)	40.9% (160)	30.7% (120)	15.3% (60)	31.0	27.1% (106)	
# 014	ESP	182	3.3% (6)	41.8% (76)	47.8% (87)	7.1% (13)	31.3	13.2% (24)	

# 015	WSP	219	9.1% (20)	41.6% (91)	44.7% (98)	4.6% (10)	31.3	21.9% (48)
# 016	Manus	391	2.0% (8)	43.0% (168)	41.4% (162)	13.6% (53)	32.0	11.0% (43)
# 017	NIP	322	2.5% (8)	36.6% (118)	56.8% (183)	4.0% (13)	32.4	8.1% (26)
# 018	ENB	486	10.5% (51)	54.3% (264)	31.5% (153)	3.7% (18)	27.6	28.2% (137)
# 019	WNB	306	5.6% (17)	38.6% (118)	50.7% (155)	5.2% (16)	31.5	9.5% (29)
# 020	AROB	123	4.9% (6)	33.3% (41)	54.5% (67)	7.3% (9)	32.7	16.3% (20)
# 021	Hela	140	0	13.6% (19)	69.3% (97)	17.1% (24)	35.4	0
# 022	Jiwaka	357	1.1% (4)	21.8% (78)	62.5% (223)	14.6% (52)	35.6	5.0% (18)

- While it is recommended that the definition of “no iodine” be maintained in different settings, the definitions of Inadequate, Adequate, and Excess Iodine should be modified based on national standards, which is the PNG Salt Legislation [2, 3]
- Medians are based only on salt samples with Iodine >5.0 mg/kg [6].

Iodine content in the salt samples:

A total of 5442 zip-locked polythene bags with salt samples were received. The brand names of most of the salt samples were indicated on the labels on the zip-locked bags as shown on the attached Excel spreadsheet (*DHS 2nd report HH salt results by provinces*). On inspection, the salt samples can be categorized as fine table salt, typical of the common brands of table salt sold in the National Capital District (NCD) PNG.

The results obtained for the iodine content in the 5428 salt samples from 21 of the 22 provinces are presented in the attached Excel spreadsheet and summarized in Table 1, using the format recommended in the recent UNICEF guidelines for the presentation of results on the monitoring of salt iodization programs [6].

Some of the recommended guidelines used in the format of the table included the following:

- *Strata are illustrative and should be modified and adapted as required and as programmatically relevant.*
- *While it is recommended that the definition of “no iodine” is maintained in different settings, definitions of “Inadequate”, “Adequate” and “Excess” iodine should be modified based on national standards, (the cut-off points in the PNG Salt Legislation [2, 3] is used in the present results).*
- *Median should be based only on salt samples with >5mg of iodine per kg of salt.*

As already stated above (*criteria for interpretation of results*), and as shown in Table 1, the adjusted cut-off points “30.0 to 50.0mg/kg” are used to define “Inadequate”, “Adequate” and “Excess” iodine in the salt samples. This is important for the purpose of comparing the salt iodine results with other recently published data on salt iodization in PNG.

Cut-off points: 30.0 to 50.0mg/kg (cut-off points used in most publications on salt iodization in PNG):

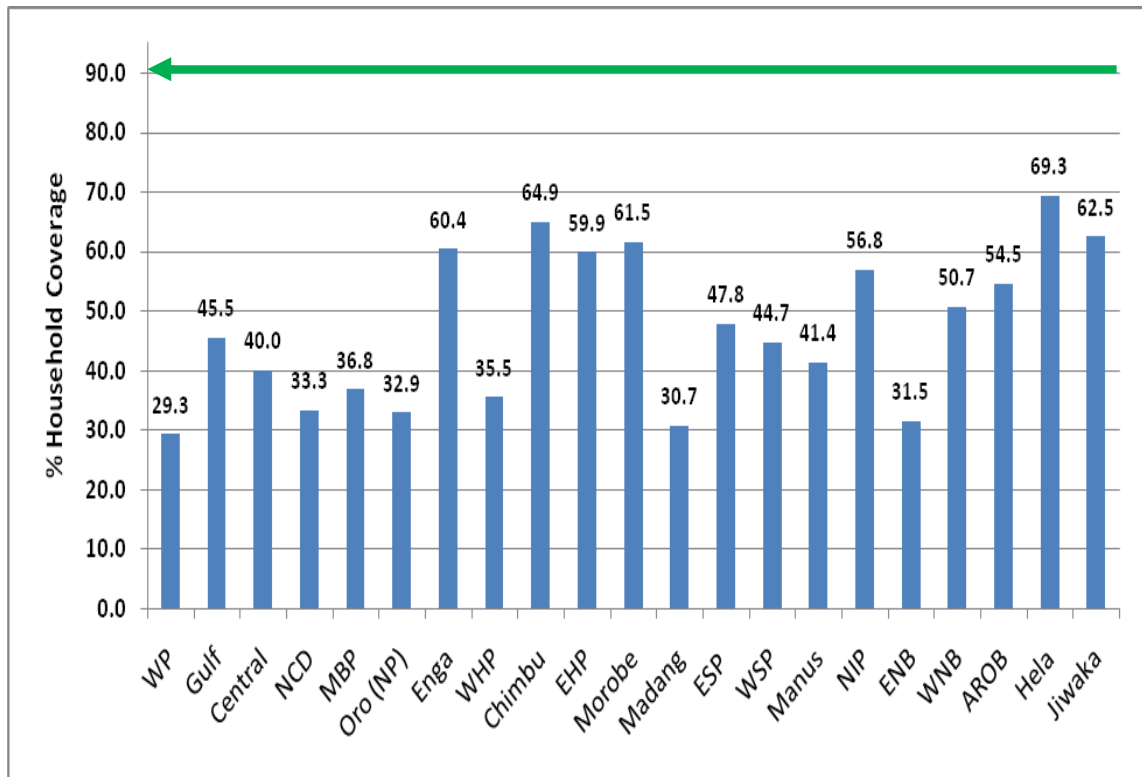
- *Range indicating “Inadequate iodine” is 5.0 to 29.9mg/kg;*
- *Range indicating “Adequate iodine” is 30.0 to 50.0mg/kg;*
- *Range indicating “Excess iodine” is >50.0mg/kg.*

The results in Table 2, which is extracted from Table 1, show the percent of households in the 21 provinces with adequately (highlighted) iodized salt. According to the WHO/UNICEF/ICCIDD [4] over 90% of households should be using adequately iodized salt, indicating adequate coverage of salt iodization. This criterion has not been fulfilled in any of the 21 provinces. The result is more clearly illustrated further in Fig. 1. The lowest level of coverage was in Western province with 29.3%, followed by Madang with 30.7% coverage. The

adequately iodized salt coverage was below 45% in 9 (42.9%) of the 21 provinces. Adequate salt iodization remains the main strategy for achieving sustained iodine deficiency disorders (IDD) control, and global experience has demonstrated that the iodization of food grade salt is the most equitable, effective and sustainable strategy to ensure optimal iodine nutrition for all population groups [4].

Codes for provinces	Names of Provinces	Number of salt	<5.0mg/kg	Inadequate: 5 – 29.9mg/kg	Adequate: 30 – 50mg/kg	Excess: > 50mg/kg
# 001	WP	198	6.1%	35.9%	29.3%	28.8%
# 002	Gulf	134	0.7%	23.1%	45.5%	30.6%
# 003	Central	265	2.3%	17.4%	40.0%	40.4%
# 004	NCD	469	6.8%	16.4%	33.3%	43.5%
# 005	MBP	342	3.2%	33.6%	36.8%	26.3%
# 006	Oro (NP)	161	19.9%	35.4%	32.9%	11.8%
# 007	SHP	--				
# 008	Enga	212	4.2%	12.7%	60.4%	22.6%
# 009	WHP	141	2.1%	21.3%	35.5%	41.1%
# 010	Chimbu	114	2.6%	25.4%	64.9%	7.0%
# 011	EHP	163	1.2%	16.0%	59.5%	23.3%
# 012	Morobe	314	1.9%	9.9%	61.5%	26.8%
# 013	Madang	391	13.0%	40.9%	30.7%	15.3%
# 014	ESP	182	3.3%	41.8%	47.8%	7.1%
# 015	WSP	219	9.1%	41.6%	44.7%	4.6%
# 016	Manus	391	2.0%	43.0%	41.4%	13.6%
# 017	NIP	322	2.5%	36.6%	56.8%	4.0%
# 018	ENB	486	10.5%	54.3%	31.5%	3.7%
# 019	WNB	306	5.6%	38.6%	50.7%	5.2%
# 020	AROB	123	4.9%	33.3%	54.5%	7.3%
# 021	Hela	140	0	13.6%	69.3%	17.1%
# 022	Jiwaka	357	1.1%	21.8%	62.5%	14.6%

Fig. 1: % distribution of households with adequately iodized salt (30 to 50mg/kg) in the 21 provinces



This Figure also illustrates the % of households with adequately iodized salt compared to the 90% coverage required (green arrow)

The low percentage of households with adequately iodized salt in all the provinces should be of concern to the authorities because of the severe consequence of iodine deficiency on pregnant and lactating mothers and on the developing brains of neonates [1].

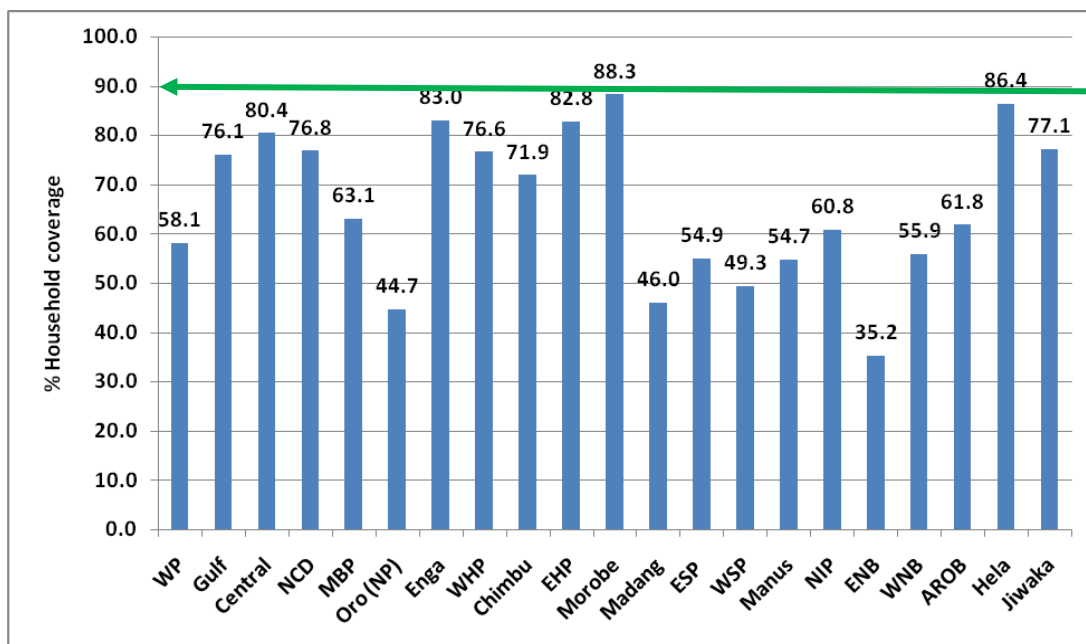
One of the generally acceptable concepts is that it is better to consume salt containing more iodine than less iodine [4]. Table 3 shows the recalculation of the results for coverage of iodized salt in the households in the various provinces. This was done by taking the sum of the households with adequate and excess iodine. The results obtained are presented in Table 3 and illustrated in Fig. 2. The criterion was still not fulfilled by any of the provinces because the combined results were still below the 90% recommended coverage.

The ENB was the province with the lowest (31.5%) coverage, followed by Oro (32.9%), Madang (30.7%) and WSP (44.7%).

Table 3: Combined % distribution of adequate and excess iodine content in salt from the households based on the cut-off points in PNG salt legislation

Codes for provinces	Names of Provinces	Number of salt	<5.0 mg/kg	Inadequate: 5 – 29.9 mg/kg	Adequate: 30 – 50 mg/kg	Excess: > 50 mg/kg	Combined (mg/kg)
# 001	WP	198	6.1%	35.9%	29.3%	28.8%	58.1%
# 002	Gulf	134	0.7%	23.1%	45.5%	30.6%	76.1%
# 003	Central	265	2.3%	17.4%	40.0%	40.4%	80.4%
# 004	NCD	469	6.8%	16.4%	33.3%	43.5%	76.8%
# 005	MBP	342	3.2%	33.6%	36.8%	26.3%	63.1%
# 006	Oro (NP)	161	19.9%	35.4%	32.9%	11.8%	44.7%
# 007	SHP	--					
# 008	Enga	212	4.2%	12.7%	60.4%	22.6%	83.0%
# 009	WHP	141	2.1%	21.3%	35.5%	41.1%	76.6%
# 010	Chimbu	114	2.6%	25.4%	64.9%	7.0%	71.9%
# 011	EHP	163	1.2%	16.0%	59.5%	23.3%	82.8%
# 012	Morobe	314	1.9%	9.9%	61.5%	26.8%	88.3%
# 013	Madang	391	13.0%	40.9%	30.7%	15.3%	46.0%
# 014	ESP	182	3.3%	41.8%	47.8%	7.1%	54.9%
# 015	WSP	219	9.1%	41.6%	44.7%	4.6%	49.3%
# 016	Manus	391	2.0%	43.0%	41.4%	13.6%	55.0%
# 017	NIP	322	2.5%	36.6%	56.8%	4.0%	60.8%
# 018	ENB	486	10.5%	54.3%	31.5%	3.7%	35.2%
# 019	WNB	306	5.6%	38.6%	50.7%	5.2%	55.9%
# 020	AROB	123	4.9%	33.3%	54.5%	7.3%	61.8%
# 021	Hela	140	0	13.6%	69.3%	17.1%	86.4%
# 022	Jiwaka	357	1.1%	21.8%	62.5%	14.6%	77.1%

Fig. 2: % distribution of households according to the sum of adequate (30 to 50mg/kg) and excess (>50mg/kg) iodine content in salt



This Figure also illustrates the % of households with combined (adequate + excess) data, compared to the 90% coverage required (green arrow).

The median iodine content (mg/kg) in the salt samples from the households in the 21 provinces is presented in Table 4. With the exception of ENB (median = 27.6mg/kg), the median iodine content is greater than 30.0mg/kg in the salt samples from all the other provinces.

According to the WHO/UNICEF/ICCIDD [4, 5] household salt with iodine content $\geq 15.0\text{mg/kg}$ is considered as adequately iodised. Table 4 shows the percent of households in the 21 provinces with salt iodine content below 15.0mg/kg.

Table 4: Median iodine content in the salt samples from the various provinces and % of salt with iodine content below 15.0mg/kg				
Codes for provinces	Names of Provinces	Number of salt	Median (mg/kg)	<15mg/kg
# 001	WP	198	34.3	10.6% (21)
# 002	Gulf	134	39.0	4.5% (6)
# 003	Central	265	44.5	4.5% (12)
# 004	NCD	469	48.3	11.5% (54)
# 005	MBP	342	36.0	7.9% (27)
# 006	Oro (NP)	161	31.6	28.6% (46)
# 007	SHP	--		
# 008	Enga	212	40.4	6.1% (13)
# 009	WHP	141	40.9	3.5% (5)
# 010	Chimbu	114	35.5	7.0%(8)
# 011	EHP	163	39.0	2.5% (4)
# 012	Morobe	314	40.9	3.2% (10)
# 013	Madang	391	31.0	27.1% (106)
# 014	ESP	182	31.3	13.2% (24)
# 015	WSP	219	31.3	21.9% (48)
# 016	Manus	391	32.0	11.0% (43)
# 017	NIP	322	32.4	8.1% (26)
# 018	ENB	486	27.6	28.2% (137)
# 019	WNB	306	31.5	9.5% (29)
# 020	AROB	123	32.7	16.3 (20)
# 021	Hela	140	35.4	0
# 022	Jiwaka	357	35.6	5.0% (18)

Additional comments and further analysis of the data can be presented on request.

NB:

- The number of households selected for each of the provinces should be provided to enable calculation of the % households with no salt on the day of sample collection.
- Alternatively, the number of households with no salt on the day of the sample collection should be given separately.
- Any other information that will enable the calculation of the households without salt should be provided.

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