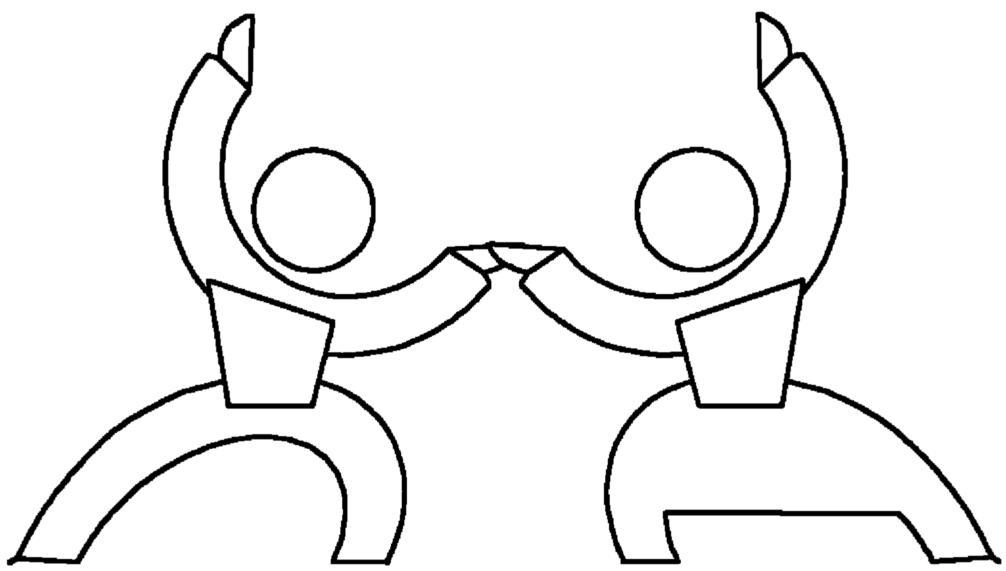
NATIONAL IODINE SURVEY

BELIZE 1994-1995



June 1995

INCAP Publication DCI/011

With the technical and financial support of the Panamerican Health Organization/World Health Organization (PAHO/WHO), the Institute of Nutrition of Central America and Panama (INCAP) and the United Nations Children's Fund (UNICEF)

CONTENTS

1. INTRODUCTION

Lack of information on availability of iodine in the diet and the status of iodine deficiency disorders (IDD) in Belize led to the formulation and implementation of this National Iodine Survey. This study was completed as a result of a collaborative effort between the Ministries of Health and Education.

2. OBJECTIVES

The survey was done to fulfill the following objectives:

2.1. General Objective

To assess the iodine status of the population of Belize for control and prevention of iodine deficiency disorders.

2.2. Specific Objectives

To estimate the prevalence of iodine deficiency, through testing of urinary iodine excretion in children aged seven to fourteen years.

To ascertain the home availability of iodized salt and the levels of iodine fortification of domestic salt.

To identify high risk groups vulnerable to iodine deficiency.

3. BACKGROUND

Prior to this study, there was no available information on the status of iodine deficiency disorders within the Belize population. There was also no knowledge of the availability or quality of iodized salt. It was assumed that Belize imported salt from neighboring countries such as Mexico, Central American countries, the United States, and the Caribbean Islands.

There was no available information on the status of iodine deficiency

Lack of iodine in the diet leads to growth and mental retardation

Iodine was found as essential to the human body in 1850. A lack of iodine in the diet results in iodine deficiency disorders. These include:

- *Goitre* - a swelling of the thyroid gland, at the front of the neck;
- *Mental retardation* - ranging from mild to severe and untreatable if present at birth, sometimes linked with defects in the development of the nervous system;
- *Hypothyroidism* - which produces sluggishness and general lethargy;
- *Growth retardation* - stunting growth, both physical and mental, and sometimes leaving children deaf and mute;
- *Reproductive failure* - miscarriages, stillbirths and problem pregnancies are much more common in areas of iodine deficiency;
- *Childhood deaths* - children born in iodine deficient areas are less likely to survive than those whose mothers had sufficient iodine in their diets during pregnancy; and
- *Socioeconomic stagnation* - in communities where the diet lacks iodine, people will be generally mentally slower and lacking energy, making them harder to educate and less motivated and productive.

4. METHODOLOGY

4.1 Sample Design

The study was based on a two stage cluster sampling design stratified by residence, urban and rural. The first stage was a random sample of clusters selected with probability proportional to the size of the schools. Some larger schools therefore contained more than one cluster. Cluster elements were selected by a systematic sampling scheme using a fixed range among elements in each school. The size of the cluster was 35 students and the design effect proposed was of 2.0 with an intra-cluster correlation of 0.0294 in the prevalence of low levels of iodine excretion in urine.

The urban and rural strata included 1015 and 735 students respectively, adjusted for the design effect. The sample size estimate for each stratum was based on a "guessed" estimate of 20 per cent prevalence of low levels of iodine in urine (less than 10 mcg/dl), an absolute error of four per cent and a 95 per cent confidence coefficient of the estimate.

4.2 Data Collection

The study included 1656 out of 1760 (94.1% of planned sample size) students from all six districts of the country, listed approximately from north to south: Corozal, Orange Walk, Cayo, Belize, Stann Creek and Toledo. The sample size for each district was proportional to its school population. A sub-sample of 1295 children were selected to have salt samples collected during the survey as representative of the households from which the surveyed children came.

A representative sample of 1,656 school childen were measured for urinary iodine and a sub-sample of 1,295 table salt samples were measured for iodine content.

Urine sample collection and handling was performed using standard procedures (INCAP). Spot urine samples were kept in ice-boxes at $+4/+8^{0}$c for the remainder of each data collection day. The collected samples were then stored refrigerated at $+2/+4^{0}$c until they were transported to INCAP in Guatemala City for analysis. Urinary iodine and creatinine were assayed following standard calorimetric techniques.

Salt samples of approximately 60 grams, were brought by children from each household on the day of the survey. Salt iodine was measured at INCAP laboratories according to the type of iodizing agent used for fortification.

4.3 Field and Laboratory Sampling Yields

A total of 1664 urine samples were collected (94.5% of planned sample size), 960 in urban areas and 704 in rural areas. From these, 1656 collected urine samples were evaluated for iodine content (94.1% of planned sample size), 960 and 696 from urban and rural areas, respectively. Iodine in urine as well as iodine in salt were determined using a modified procedure based on the Sandell and Kolthoff reaction after liberating iodine with sulphuric acid. The modified procedure determined iodine as potassium iodate or potassium iodide.

4.4 Data Analysis

The data analysis was performed by means of the programme Csample of the computational package Epi-Info version 6.0. The estimates were obtained by residence areas and by districts.

5. RESULTS

The results are presented in three parts: the first is related to urinary iodine, the second to the iodine concentration of table salt, and the third to the relation between salt iodine content and iodine in urine excretion.

5.1 Urinary Iodine

The overall goal of measuring urinary iodine is to identify, monitor and correct iodine deficiency status

The overall goal of measuring urinary iodine is to identify, monitor and correct iodine deficiency status. Urinary iodine determination is the most useful biochemical outcome indicator for assessment of a population's iodine status (ICCIDD Newsletter, 1993; 9(4):40-43). Usually, an amount equivalent to 80-90 per cent of the daily intake of iodine is excreted by the kidneys. In the field, urine is easier to obtain than blood samples, and urinary iodine behaves in a more stable fashion than serum hormones. Moreover, for a smaller cost, urinary iodine gives more metabolic information than thyroid hormones.

According to WHO's proposed epidemiological criteria for assessing the severity of iodine deficiency disorders, a median urinary iodine value of more than 10mcg/dl demonstrate that there is no iodine deficiency. See Table 1.

Table 1: IDD Severity and the Need for Correction

Stage (Degree of Deficiency)	Median Urinary Excretion (mcg/dl)	Need for Correction of Iodine Deficiency
0 (no deficiency)	more than 10.0	
1 (mild)	5.0 - 9.9	Important
2 (moderate)	2.0 - 4.9	Urgent
3 (severe)	less than 2.0	Critical

Source: Noguera, Z.A. Eliminar la Deficiencia de Yodo: Un reto de fin de siglo. Bol Of Sanit Panam 1994; 117(6):483-495

Figure 1 describes the cumulative distribution of iodine in urine samples. The median urinary iodine values for Belize, Cayo, Stann Creek and Toledo are close to 15mcg/dl. The medians for Corozal and Orange Walk are 25.1 and 36.5 mcg/dl respectively. This demonstrates that none of the districts have an iodine deficiency status. The percentage of children at risk, based on the overall prevalence or urinary iodine excretion levels below 5mcg/dl is 5.5 per cent, ranging from 1.5 per cent in Corozal District to 8.2 per cent in the Belize District (see Table 3). The prevalence of urinary iodine excretion below 5mcg/dl for the urban stratum was 4.8 per cent and for the rural stratum, 6.5 per cent.

None of the districts have an iodine deficiency status

Figure 1 and Table 2 indicate that Belize has no iodine deficiency. Hence, it is safe to assume that current dietary habits guarantee the Belizean population an adequate level of iodine. This in turn will prevent the health and socio-economic consequences of iodine deficiency and its related disorders. Establishing this fact will also aid health and development planners to locate iodine status surveillance in a list of priorities that responds to national needs and resources more rationally.

Belize has no iodine deficiency

As may be noted in Table 2, the estimated median urinary iodine ranges from about 15mcg/dl in Toledo, Cayo, Belize and Stann Creek to over 25mcg/dl in Corozal and Orange Walk. There is practically no overlap between the confidence intervals for urinary iodine from Orange Walk and the four southern districts. The apparent polarization of urinary iodine excretion (an indirect measure of iodine intake) may be explained by commercial/cultural exchange with the United States, Mexico, Caribbean and European countries. If this were the case, a partial explanation for higher iodine intakes in northern Belize exists. Moreover, there may be a certain dependence on processed foods for what may be called "complementary iodine", given that Corozal and Orange Walk both show an almost two-fold greater urinary iodine excretion than the other districts. Another potential explanation is that the food pattern in these two districts includes seafood consumption as one of the main components of the diet, which could explain the adequate fulfillment of iodine requirements.

One of the goals for virtual elimination of Iodine Deficiency Disorders is that 50 per cent of the population have more than 10mcg/dl of iodine excretion in urine, and that 80 per cent have more than five mcg/dl. Belize has achieved this goal since 84 per cent of the national population has excretions of more than 10mcg/dl and 95.5 per cent have more than 5mcg/dl. (See Table 3)

Belize has achieved the goal of virtual elimination of IDD

5.2 Salt Iodine

The consumed table salt was found to be iodized in 97.5 per cent of the samples at the country level, the lowest being 95.3 per cent in the Stann Creek District. The median concentrations of iodine in salt at the country level were estimated at 10.7mcg/g, ranging from 8.75mcg/g in Toledo to 12.15 mcg/g in Cayo (Table 4 and Figure 2).

Table salt was iodized in 97.5 per cent

In contrast with urinary iodine values, the concentration of iodine in salt is relatively more homogeneous across districts. The district medians (8.3 - 15.2mcg/g) for salt iodine may be insufficient levels of iodine at household level.

The amount of iodine found in salt at household level may be insufficient

Maximum values of 91, 67 and 80 mcg/g were detected in samples from Belize, Cayo and Orange Walk, respectively. These are safe iodine concentrations, if the daily salt intake is of 10g. However, if salt intake were greater (say 15g/day) and the fortified salt had the maximum levels of iodine under consideration, the intake of iodine could represent a small and not significant risk for susceptible adults - those with pre-existing hyperactive thyroid modules and/or cardiac dysrhytmias sensitive to transitory increases of circulating thyroid hormone activity. (ICCIDD Newsletter, 1994; 10(4):42).

Samples of table salt showed median iodine levels around 10mcg/g. It is assumed that this salt comes from Mexico, where table salt is normally iodized with potassium iodide at 10mcg/g. The salt with maximum values of iodine, found in Belize, Cayo and Orange Walk District, probably comes from other Central American countries, where the range of iodine in salt is between 30 and 100 mcg/g. Other fortified salt probably comes from the USA.

5.3 Salt Iodine and Iodine Urine Excretion

Figure 3 describes the median concentrations of iodine in urine (mcg/dl) and in salt (mcg/g). There is a significant and unexpected discrepancy between the levels of iodine in urine and those in salt for the Orange Walk and Corozal Districts. For example in Orange Walk, the relationship between iodine excretion in urine and iodine in salt is 36.3 mcg/dl versus 11.8 mcg/g. In Cayo it is 15.1 mcg/dl versus 12.2 mcg/g. This latter relationship is the more usual situation.

For countries where salt is produced locally or its commerce is regulated by law-enforcement or sanitary agencies, monitoring the iodine content of salt is the most productive indicator of iodine control. In a country like Belize, where the climate is warm and moist, the ICCIDD/WHO/UNICEF joint expert committee has recommended that at least 90 per cent of all household salt be required to have no less than 30mcg of iodine per gram. This level of fortification is intended to guarantee a daily intake of 150mcg iodine the currently recommended iodine allowance for adults. This recommendation assumes (1) a mean salt intake of 10g/day; and (2) a 40 per cent loss of available iodine due to cooking processes.

All household salt is required to have no less thar. 30mcg of iodine per gram

From the data in Table 3 it is evident that salt consumed in Belizean households falls far short of this recommendation. Only approximately five per cent of salt sampled in this survey contained iodine at 25mcg/g or more. However, it is also evident from urinary iodine results that average iodine intake is adequate in Belize. Even though there are no estimates of mean salt consumption levels for the country, 15g/day would seem a more realistic figure, given the rates of perspiration and the climate of Belize. Additionally, from the previous discussion it may be reasonable to assume that - at least for the northern districts of Corozal and Orange Walk - there may be other significant sources of dietary iodine than fortified salt.

Urinary iodine levels fall within recommended values, even though salt iodine levels seem to fall short of recent recommendations for domestic salt (ICCIDD Newsletter, 1994; 10(4):37-41). The two most feasible explanations are:

- that on average, Belizeans consume more than 10g/day of salt,
- that in addition to a fortified salt intake of approximately 10g/day, there are other important dietary sources of iodine in the traditional Belizean diet, particularly in the north.

The most probable source for the high levels of iodine found in the urine samples from Corozal and Orange Walk may be iodized salt used for food processing. On the other hand, the country's north-to-south trend described by the urinary iodine results may reflect the iodine content of the local food chain, ie. the iodine content of soil and water. In practical terms, a combination of both food processing and geophysical factors will usually explain the observed phenomenon.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

- Currently Belize imports 100 per cent of the salt that it consumes. The main countries providing salt to Belize are Mexico, the United States and probably other Central American countries.

- 97.5% of the salt consumed is iodized.

- Although fortification of table salt with iodine is almost universal, the levels of iodine in the salt consumed in the country may be insufficient.

- No iodine deficiency was detected in Belize; urinary iodine excretion showed adequate iodine intake.

- Corozal and Orange Walk Districts have increased iodine intake, probably related to sources of iodine other than table salt.

- Urinary iodine levels found in Corozal and Orange Walk may be an indication that average salt consumption in these areas may be higher than in other districts.

- There is no appreciable difference between iodine intake and excretion in urban and rural areas.

6.2 Recommendations

- To establish compulsory standards for levels of iodine to be present in all salt imported into Belize for human and animal consumption. The recommended level of fortification should be 30-50mcg/g.

- To implement a monitoring and surveillance system to ensure the appropriate iodine levels in all salt.

- To explore the sources of high iodine intake and the implications of a possible excessive consumption of foods processed with salt for the health profile of the population at risk of cardiovascular disease.

Table 2
Levels of Iodine (mcg/dl) in Urine by District, Belize 1994-95

District or Area	Sample size (n)	Mean	Confidence Limits (95%)		Std. Error	Median	Minimum	Maximum	Sampling Design	
			Lower	Upper					Mean of Cluster Size	Effect (DEFF)
Belize	499	18.5	16.1	20.9	1.23	16.8	0.2	111.2	33.3	4.5
Cayo	376	16.7	14.4	19.1	1.21	15.1	0	77.9	34.2	5.8
Corozal	202	35.0	16.9	53.1	9.24	25.6	2.7	188.5	33.7	18.4
O.Walk	294	41.4	33.7	49.1	3.93	36.3	3.3	173.0	32.7	7.7
Stann Creek	139	16.5	15.4	17.6	0.58	15.7	2.1	70.4	34.8	1.0
Toledo	146	16.3	15.2	17.5	0.59	15.5	3.1	64.3	30.8	0.9
Country	**1656**	**23.8**	**19.9**	**27.7**	**2.0**	**18.4**	**0**	**188.5**	**33.3**	**15.6**
Urban	960	22.8	19.1	26.5	1.89	18.6	0.2	173	33.1	11.3
Rural	696	25.8	17.5	32.8	3.92	17.8	0	188.5	33.1	14.1

Table 3
Prevalence (%) of Deficient Levels of Iodine in Urine (<5mcg/dl) by District, Belize 1994 - 95

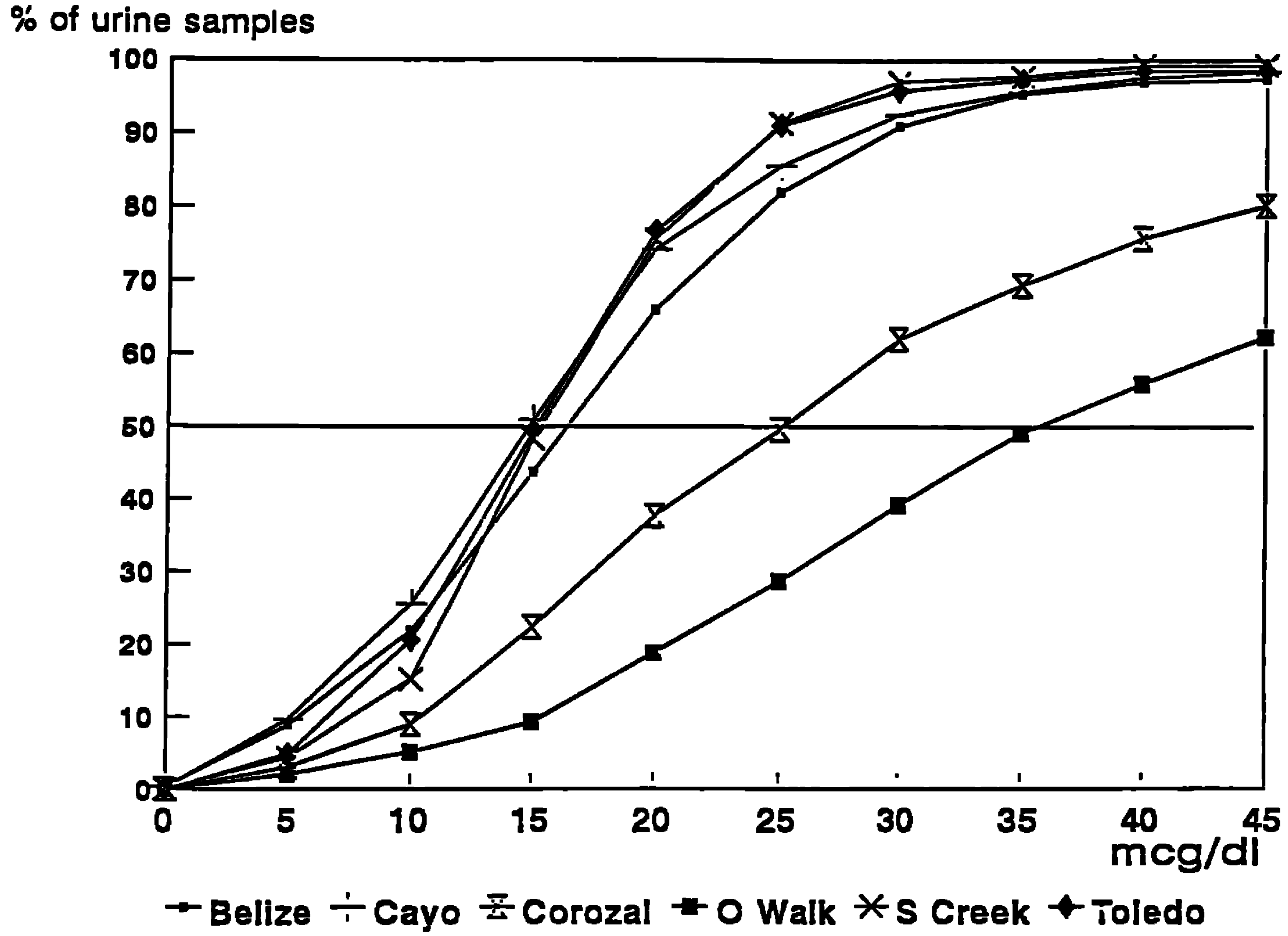
District or Area	Sample size (n)	Prevalence (%)	Confidence Limits (95%)		Standard Error (%)	Sampling Design	
			Lower	Upper		Mean of cluster Size	Effect (DEFF)
Belize	499	8.2	3.2	13.2	2.5	33.3	4.3
Cayo	376	8.0	3.0	12.9	2.5	34.2	3.3
Corozal	202	1.5	0	3.3	0.9	33.7	1.2
Orange Walk	297	2.0	0	4.1	1.1	32.7	1.7
Stann Creek	139	3.6	1.3	5.9	1.2	34.8	0.6
Toledo	146	4.1	2.3	6.0	0.9	30.8	0.3
Country	**1656**	**5.5**	**3.4**	**7.6**	**1.1**	**33.3**	**3.7**
Urban	960	4.8	3.5	6.1	0.7	33.1	0.9
Rural	696	6.5	1.8	11.1	2.4	33.5	6.5

Table 4
Levels of Iodine (mcg/g) in salt by district, Belize 1994

District	Sample size (n)	Mean	Confidence Limits (95%)		Std. Error	Median	Minimum	Maximum	Sampling Design	
			Lower	Upper					Mean of cluster Size	Effect (DEFF)
Belize	321	12.8	10.3	15.2	1.3	10.5	0	91.6	26.8	3.5
Cayo	322	13.0	11.4	14.5	0.8	12.2	0	67.2	29.3	3.0
Corozal	144	10.2	8.9	11.5	0.7	9.7	0	25.3	28.8	4.5
Orange Walk	282	13.1	11.3	14.8	0.9	11.8	0	80.2	31.3	3.5
Stann Creek	106	9.8	8.3	11.3	0.8	9.4	0	37.4	26.0	3.0
Toledo	120	9.4	8.3	10.6	0.6	8.8	0.4	55.6	24.0	0.8
Country	**1295**	**12.0**	**11.1**	**13.0**	**0.5**	**10.7**	**0**	**91.6**	**28.2**	**3.6**
Urban	670	12.2	10.7	13.6	0.7	10.6	0	91.6	26.8	3.7
Rural	625	11.9	10.7	13.1	0.6	10.7	0	80.2	29.7	3.4

Figure 1

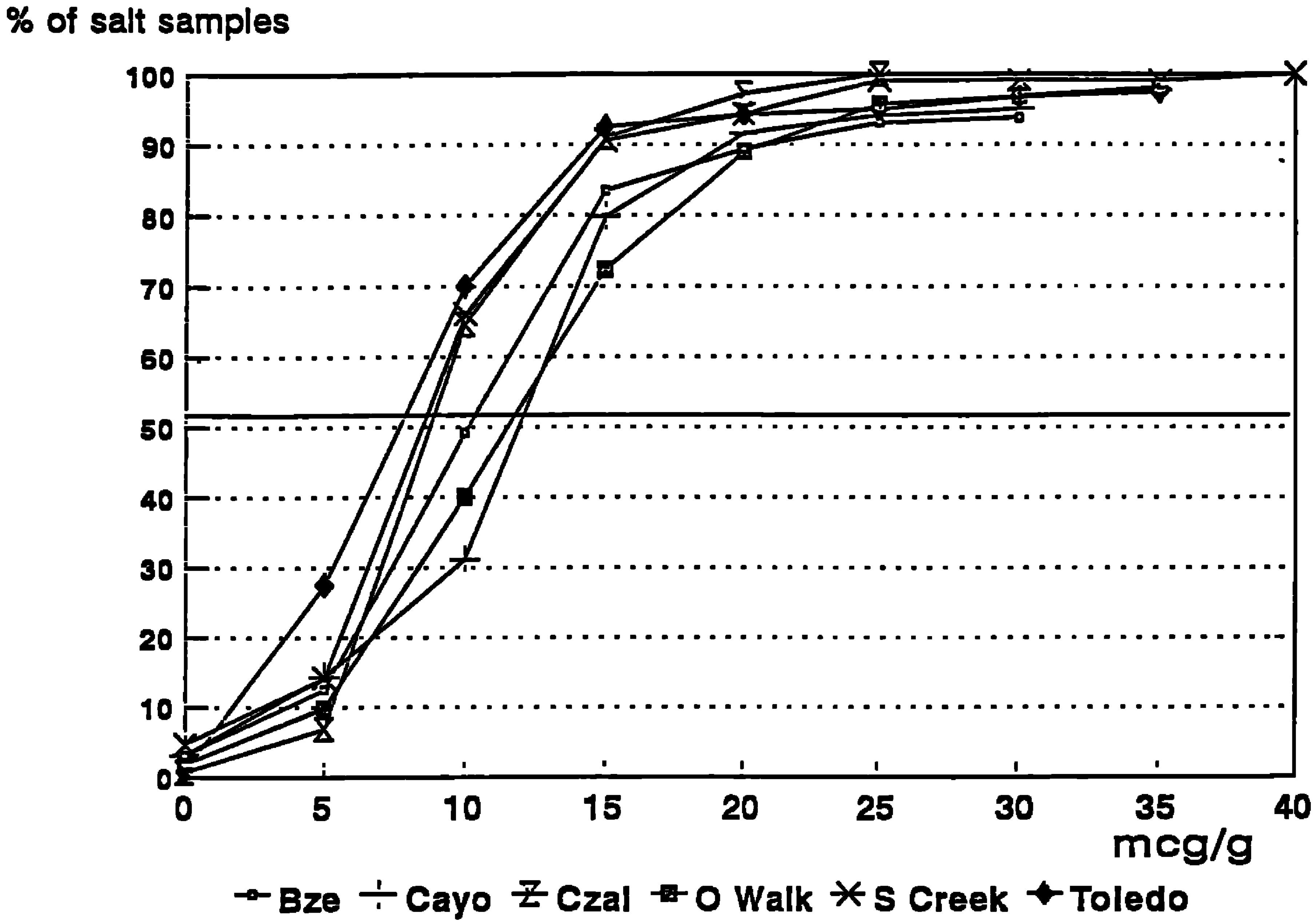
IODINE IN URINE (mcg/dl) CUMULATIVE DISTRIBUTION BY DISTRICT. BELIZE 1994-95.



Source: National Iodine Survey, Belize 1994-95.

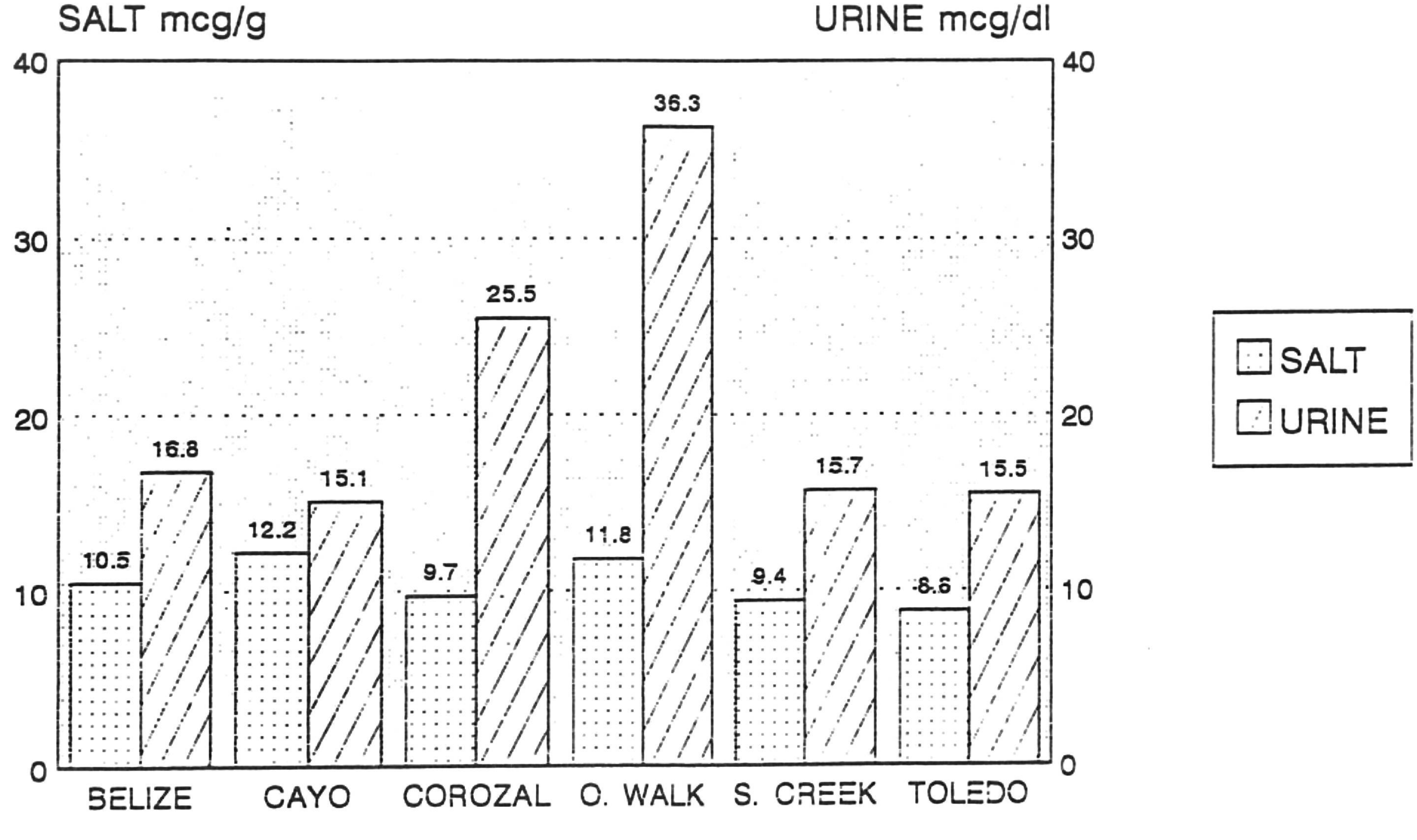
Figure 2

IODINE IN TABLE SALT (mcg/g) CUMULATIVE DISTRIBUTION BY DISTRICT. BELIZE 1994-95.



Source: National Iodine Survey, Belize 1994-95.
PPM = mcg/g

Figure 3
MEDIANS OF IODINE IN SALT (mcg/g) AND IN URINE (mcg/dl) BY DISTRICT
BELIZE 1994-95



Source: National Iodine Survey. Belize 1994-95.
PPM = mcg/g

ACKNOWLEDGEMENTS

NATIONAL AUTHORITIES

Hon. Ruben Campos, Minister, Ministry of Health and Sports
Hon. Elodio Aragon, Minister, Ministry of Education
Dr. Jose Lopez, Director of Health Services, Ministry of Health and Sports
Mr. Ernest Raymond, Chief Education Officer, Ministry of Education

TECHNICAL AND FINANCIAL COOPERATION

Dr. Daniel Gutierrez, PAHO/WHO Representative-Belize
Dr. Vladimir Rathauser, Former PAHO/WHO Representative-Belize
Ms. Dorothy Rozga, UNICEF Liaison Officer-Belize
Dr. Hernan Delgado, Director of INCAP/PAHO
Lic. Patricia Pálma, INCAP
Dr. Arnulfo Noguera, INCAP
Dr. Rafael Flores, INCAP
Dr. Omar Dary, INCAP
Lic. Dora Ines Mazariegos, INCAP
Dr. Ricardo Sibrian, INCAP
Dr. Erick Boy, INCAP
Ms. Lorraine Thompson, UNICEF
Mr. Derek Warren, UNICEF

PARTICIPANTS

Mr. Alberto Chulin, Deputy Chief Education Officer, Ministry of Education
Dr. Ramon Figueroa, Maternal and Health Care Director
Mrs Maria Magana, Survey Coordinator
Mr. James Gardiner, Intern, State University of New York
Mr. Wallwyn Tillett, Director, Laboratory Services, Ministry of Health
Mrs. Gilda Richardson, Nutritionist, Ministry of Health
Mrs. Araceli Moguel, Supervisor, Public Health Nurses
Mrs. Dorla McKenzie, Senior Public Health Nurse

Thanks are extended to all the local managers, principals, teachers and children who participated in this study.

REFERENCES

1. ICCIDD Newsletter, 1993; 9(4):40-43)
2. ICCIDD Newsletter, 1994; 10(4):37-41
3. Noguera, Z.A. Eliminar la Deficiencia de Yodo: Un reto de fin de siglo. Bol Of Sanit Panam 1994; 117(6):483-495