Nutrition 58 (2019) 134–139

Contents lists available at ScienceDirect

Nutrition

journal homepage: www.nutritionjrnl.com

Applied nutritional investigation

Current state of iodine nutrition in Filipino school-aged children

Michael E. Serafico M.Sc. *, Leah A. Perlas M.Sc., Joselita Rosario C. Ulanday B.Sc., Marco P. De Leon M.Sc., Marites V. Alibayan B.Sc., BS, Josefina A. Desnacido B.Sc., Glen Melvin P. Gironella B.Sc., Imelda A. Agdeppa Ph.D., Mario V. Capanzana Ph.D.

Department of Science and Technology-Food and Nutrition Research Institute (DOST-FNRI), DOST Complex, General Santos Avenue, Bicutan, Taguig City, Philippines

ARTICLE INFO

Article History:
Received 20 March 2018
Accepted 19 June 2018

Keywords:
Urinary iodine
Filipino
School-aged children
Iodine status

ABSTRACT

Objectives: Globally, although progress in eliminating iodine deficiency disorders (IDD) has been reported, IDD is still considered to be a global health problem. As school-aged children are the most accessible population group, their urinary iodine (UI) concentration data are accepted and used as an indicator of IDD for the general population. The aim of this study was to reassess the national, regional, and provincial estimates of UI as a measure of IDD among Filipino school-aged children.
Methods: Casual urine samples were collected from 22 588 children, 6 to 12 y of age, from participating households in the eighth National Nutrition Survey. UI was determined based on the catalytic action of iodine in the Sandell–Kolthoff reaction and IDD was evaluated using criteria from the World Health Organization, United Nations Children's Fund, International Council for Control of Iodine Deficiency Disorders criteria.
Results: The median UI level among Filipino school-aged children was 168 μg/L, corresponding to optimal iodine nutrition; whereas 23.2% had UI reflective of excessive iodine intake. Cjildren in the Zamboanga Peninsula Region had median UI level of 68 μg/L and 41.1% of participants had UI values <50 μg/L, which is indicative of mild iodine deficiency. Children from Guimaras and Zamboanga del Norte, or 2.4% of the provinces, had moderate iodine deficiency.
Conclusion: Although the median UI level of school-age children was optimal, there are pockets of inadequacy and excessive intake that need special concern for targeted intervention.

Introduction

Iodine deficiency disorders (IDD) are the leading causes of mental retardation in childhood and are collectively preventable only if early, appropriate measures are sufficiently taken [1]. These disorders lower IQ and impair the psychomotor function of young children. According to Andersson et al. [2], it is estimated that iodine deficiency affects 76 million school-age children (SAC) in Southeast Asia, the highest globally. In fact, iodine deficiency was identified by the International Child Development Steering Group as one of the four key global developmental risk factors for children to reach their potentials and that needs urgent intervention [3].

Several techniques can be used to determine the iodine status of a population including measurements of the thyroid volume, levels of thyroid-stimulating hormone, or serum thyroglobulin, and urinary iodine (UI) levels [4]. Among these, UI measurements are the most suitable in assessing dietary iodine intake and are easily accomplished during surveys. SAC were most commonly involved in surveys because of their vulnerability and easy access through schools. Their iodine status was believed to adequately represent the iodine status of the population.

UI data from 92% of the world's population from 1993 to 2004 have been used by the World Health Organization (WHO) to estimate the worldwide prevalence of IDD [1]. From these data, ~2 billion people have inadequate iodine status (UI <100 μg/L) and 36.4% of SAC have iodine deficiency. In the Philippines, UI has been used to assess iodine status since 1998.

To date, there has been progress in the elimination of IDD worldwide. The number of iodine-deficient countries decreased from 54 in 2003 to 32 in 2011 [2]. This trend was attributed largely

M.E.S. and L.A.P. conceptualized the study, supervised laboratory analysis of samples, analyzed and interpreted the results, and drafted and revised the manuscript. J.R.C.U. and M.P.d.L. took charge of urine analysis from sample preparation to calculation and encoding of results. M.V.A. and J.A.D. monitored and supervised the collection, storage, and transport of urine samples in the field. G.M.P.G. analyzed the data. I.A.A. assisted M.V.C. who was in charge of the overall operation of the N.N.S. and of the approval of the final version of the manuscript.

* Corresponding author: Tel.: +63 2 837 8113; Fax: +63 2 839 1843
E-mail address: Michaelserafico@gmail.com (M.E. Serafico).

https://doi.org/10.1016/j.nut.2018.06.023
0899-9007/

to strengthened salt-iodization programs and improved monitoring. Although IDD have been controlled remarkably, they persist as a significant global public health problem particularly in developing countries [5]. However, there is an increasing number of countries with high UI corresponding to excessive intake increasing the risk for iodine-induced hyperthyroidism [6].

Universal salt iodization is recognized as the most cost-effective strategy to prevent and control IDD. In the Philippines, an Act for Salt Iodization Nationwide (ASIN Law) was passed in 1995 in response to the increasing goiter rates among Filipinos ≥7 y of age (from 3.5% in 1987 to 6.7% in 1993) [7]. This law requires the addition of iodine to all salt intended for animal and human consumption. Eight years after its implementation, efforts of the government at eliminating IDD among Filipinos are slowly being manifested. Based on UI levels among 6- to 12-y-old Filipino SAC, from mild iodine deficiency in 1998, the Philippines attained optimum iodine status in 2008 [8]. Similar to other countries, there was an increase in the proportion of Filipino children with excessive iodine intake.

Available data on IDD in the Philippines had always been on a national level. When data from earlier surveys were disaggregated to establish regional estimates, results were not as reliable as those on the national level. Except for the 1998 NNS, where provincial estimates were generated, there is no available data at this level of disaggregation.

The 1998 data has shown that there are pockets of IDD in the country. Thus, there is a need to regenerate provincial data to identify which provinces are still at risk for IDD. This way, efforts of alleviating IDD would be targeted toward these provinces.

This project is an important follow-through of IDD prevalence surveys conducted in the country from 1998 up to the present. These surveys are vital inputs to the country's national development planning and monitoring efforts by the National Economic Development Authority and the Department of Health.

This study, therefore, determined IDD among Filipino SAC, 6 to 12 y of age, based on UI levels. Specifically, it determined UI levels and the prevalence of IDD among Filipino SAC at the national, regional, and provincial levels.

Materials and methods

Sampling design

The study employed a multistaged, stratified sampling design. The first sampling stage was the selection of the primary sampling unit, which consisted of one barangay or a contiguous barangays with ≥500 households. Second was the selection of the enumeration area (EA), which consisted of contiguous area in a barangay with 150 to 200 households. The last stage was the selection of the households in the sampled EA that served as the ultimate sampling unit.

Table 1
Epidemiologic criteria for assessment of iodine nutrition in a population based on median or range of urinary iodine concentration

Median UIE (ug/L)	Iodine intake	Iodine nutrition
<20	Insufficient	Severe iodine deficiency
20–49	Insufficient	Moderate iodine deficiency
50–99	Insufficient	Mild iodine deficiency
100–199	Adequate	Optimal
200–299	More than adequate	Risk for iodine-induced hyperthyroidism in susceptible groups
≥300	Excessive	Risk for adverse health consequences

UIE, urinary iodine excretion.

The eighth NNS covered 17 regions that involved 80 provinces. The survey used the master sample instituted by the Philippine Statistics Authority in the 2009 Labor Force Survey.

Study group

About 35 825 sample households were selected for the survey, which ran from June 19 to December 4, 2013 and from February 16 to April 15, 2014. All children, 6 to 12 y of age, from enlisted households in all provinces were included as participants. Of the 24 950 eligible SAC, urine samples were collected from 22 588, resulting in a response rate of 90.5%.

The survey protocol was reviewed and approved by the FNRI Institutional Ethics Review Committee. Assent from study participants and written informed consent from household head were obtained before the interview and urine collection.

Sample collection and urinary iodine determination

About 5 mL of midstream urine was collected from the children. The samples were placed in an ice chest while in the field and during transport. The samples were kept in a −20°C freezer until analysis.

The ammonium persulfate digestion method of Pino et al. [9] was used to determine UI concentrations. UI analysis was conducted at the Biochemical Assessment Service Laboratory of the Food and Nutrition Research Institute-Department of Science and Technology.

IDD assessment

The severity of IDD for SAC based on median UI concentration was assessed using the epidemiologic criteria set by World Health Organization, United Nations Children's Fund, and International Council for Control of Iodine Deficiency Disorders [10] shown in Table 1.

Statistical analysis

Descriptive statistics (medians, 20th percentile, 80th percentile, and prevalence of deficiencies) was generated using SPSS, Version 16 (IBM Corp, Armonk, NY, USA).

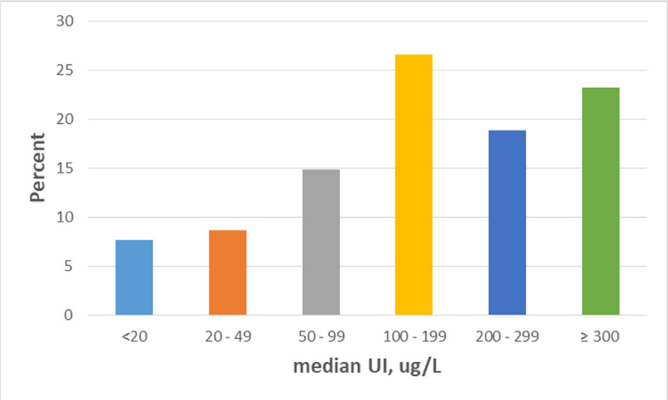

Fig. 1. Frequency distribution of urine iodine level among Filipino school-age children. UI, urine iodine.

Table 2
Median and prevalence of urinary iodine <50 ug/L among Filipino school-age children by region

Region	N	Median (P20, 80) ug/L	% <50 ug/L (95% CI)
Philippines	22 588	168 (63, 322)	16.4 (15.7–17.1)
NCR	1905	220 (104, 357)	8.9 (7.6,–0.3)
CAR	864	123 (39, 270)	26.4 (20.5–32.3)
I. Ilocos Region	1336	173 (59, 342)	17.5 (14.4–20.6)
II. Cagayan Valley	995	223 (92, 389)	10.6 (8–13.2)
III. Central Luzon	1818	203 (83, 400)	11.3 (9.3–13.3)
IV-A Calabarzon	2028	236 (107, 383)	8.1 (6.7–9.5)
IV-B Mimaropa	1046	136 (51, 373)	19.5 (15.8–23.3)
V. Bicol Region	1719	150 (53, 297)	18.7 (16.6–20.8)
VI. Western Visayas	1464	125 (42, 259)	23.4 (20.5–26.4)
VII. Central Visayas	1508	166 (69, 304)	14.7 (11.7–17.7)
VIII. Eastern Visayas	1432	161 (67, 284)	15.4 (12.9–18)
IX. Zamboanga Peninsula	1039	68 (19, 161)	41.1 (36.6–45.6)
X. Northern Mindanao	1095	121 (38, 247)	23.6 (20.1–27.1)
XI. Davao Region	1090	122 (43, 248)	24.3 (20.5, 28.1)
XII. Soccsksargen	1185	137 (50, 293)	19.9 (16.4– 23.4)
ARMM	1025	128 (48, 257)	20.6 (17.5–23.7)
Caraga	1039	128 (55, 243)	18.1 (15.1–21.2)

ARMM, Autonomous Region in Muslim Mindanao; CAR, Cordillera Administrative Region; NCR, National Capital Region.

Results

School-aged children are traditionally used as proxy for iodine status in the general population [11]. Casual urine samples were collected from 22 588 SAC from all households participating in the survey, with a coverage rate of ~90%, allowing the generation of provincial estimates of IDD prevalence.

Overall, the median UI level was 168 μg/dL, with 16.4% having values <50 μg/L. This is indicative of optimal iodine nutrition or adequate iodine intake. In terms of frequency distribution (Fig. 1), highest percentage (26.6%) of urinary iodine excretion (UIE) values were within the optimal level. This was followed by values indicating excessive intake (23.2%) and then by those who have more than adequate intake (18.9%). ID was recorded in 31.3% of the SAC.

IDD in the regions

Among the regions, Calabarzon had the highest median UI value (236 μg/L) and lowest percentage of values <50 μg/L (8.1%). Together with Calabarzon, three other regions (National Capital Region [NCR], Cagayan Valley, and Central Luzon) reached the more than adequate status, meaning that the median UI value falls between 200 and 299 μg/L. Seven regions (41%) (Ilocos, Mimaropa, Bicol, Central and Eastern Visayas, Soccsksargen, and Caraga) had optimal iodine nutrition. Likewise, it can be said that these regions

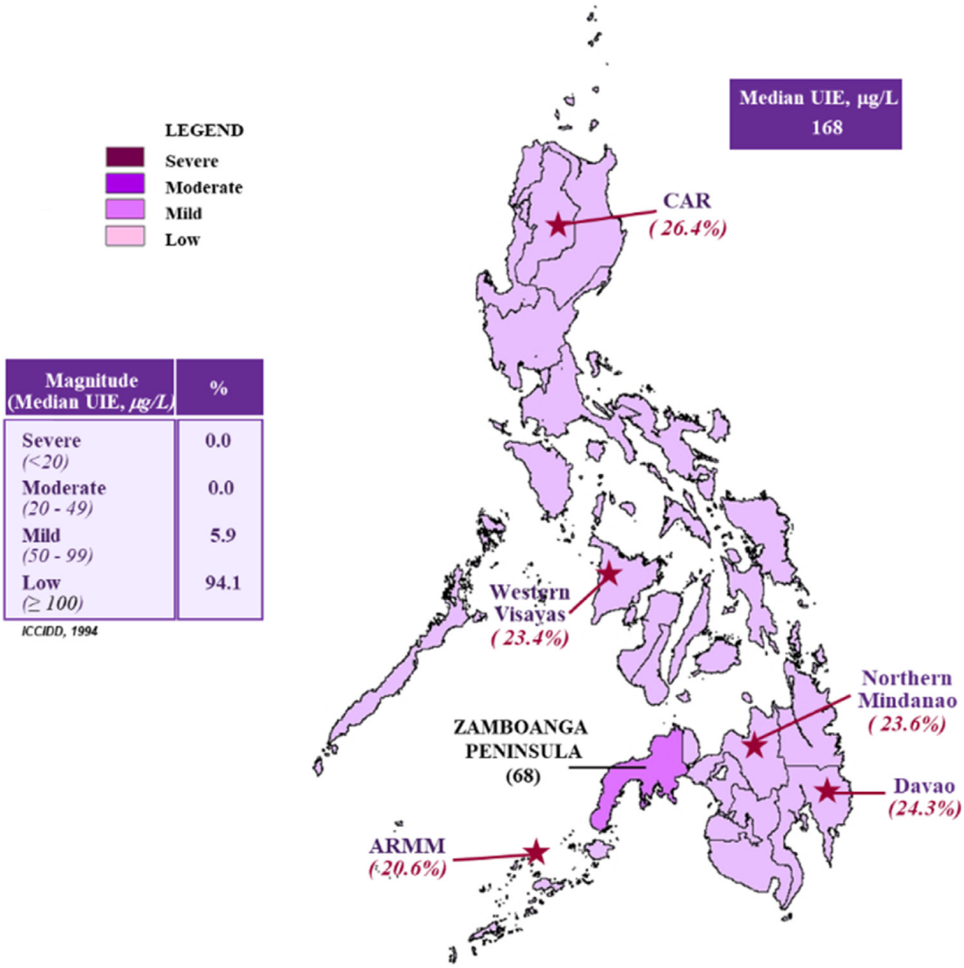

Fig. 2. Median and prevalence of urinary iodine excretion <50 ug/L by region. ARMM, Autonomous Region in Muslim Mindanao; CAR, Cordillera Administrative Region; UIE, urinary iodine excretion.

Table 3
Median and percent distribution of UI level among Filipino school-age children by island group

Island group	n	Median UIE μg/L	Frequency distribution (%) per UI range, μg/L					
			<20	20–49	50–99	100–199	200–299	≥300
Luzon	11711	199	5.9	6.6	12.5	25.3	20.6	29.2
Visayas	4404	152	8.2	9.8	16.4	29.3	18.6	17.7
Mindanao	6473	115	11.8	13.1	19.5	27.6	14.9	13.1

UI. urinary iodine; UIE, urinary iodine excretion.

successfully eliminated iodine deficiency as 50% of the UI values were >100 μg/L and ≤20% were <50 μg/L. Table 2 lists the median UI values for the Philippines and by region, the 20th and 80th percentile values and the percentage of values <50 ug/L.

Five regions obtained a median UI level of 100 to 199 μg/L but had >20% of values <50 μg/L. Cordillera, Western Visayas, Northern Mindanao, Davao, and Autonomous Region in Muslim Mindanao are the regions said to have pockets of iodine deficiency. Notably, only Zamboanga Peninsula had a median UI <100 μg/L and >20% of values were <50 μg/L, indicating iodine deficiency. A heat map depicting the iodine status per region is presented in Figure 2.

IDD by island groups

Of the three island groups, Luzon had the highest median UI level (199 μg/L) and Mindanao had the lowest (115 μg/L). All the island groups had median UI indicative of optimal iodine nutrition, that is, having a median UI level between 100 and 199 μg/L, but Mindanao had 24.9% of individuals with UI <50 μg/L, indicating pockets of deficiency (Table 3). Congruently, the highest proportion of UI levels indicative of excessive intake was recorded in Luzon at 29.2%, followed by Visayas (17.7%) and Mindanao (13.1%).

IDD in the provinces

Table 4 shows that the four districts in the NCR recorded median UI values indicating more than adequate iodine intake (200–299 ug/L). The same was true for the provinces of Ilocos Norte, Cagayan, Isabela, Quirino, Bulacan, Pampanga, Tarlac, Cavite, Laguna, Quezon, Rizal, Marinduque, and Catanduanes. It is worth noting that all these provinces with iodine status assessed to be more than adequate are in Luzon.

In the Visayas, 14 of the 16 provinces (87.5%) had optimal iodine nutrition (Table 5). Yet, Capiz and Guimaras provinces were found to be under mild and moderate iodine deficiency, respectively. The median UI value measured among SAC in Capiz was 99 μg/L; whereas those in Guimaras was 48 μg/L. Substantially, the percentages of values having <50 μg/L was 33.8% in Capiz and 52.2% in Guimaras.

Iodine status in all the provinces of Soccsksargen and Caraga are “adequate,” as presented in Table 6. In Davao Region and Autonomous Region in Muslim Mindanao, only Davao Oriental and Lanao del Sur, respectively, had insufficient iodine intake or mild iodine deficiency. Other provinces with this status were Zamboanga del Sur, Zamboanga Sibugay, Isabela City, Bukidnon, and Misamis Occidental. In Mindanao, only Zamboanga del Norte had moderate iodine deficiency with >50% of UI values <50 μg/L (55.5%) and a median of 41 μg/L.

The number and proportion of provinces according to iodine status are summarized in Table 7. Of the provinces, 54 (67.5%) had optimal iodine nutrition and 16.3% had more than adequate iodine intake. Moreover, 13 of the 80 provinces still had iron deficiency.

Table 4
Median and prevalence of urinary iodine <50 ug/L among school-age children in Luzon by province

Region	N	Median (P20, 80) ug/L	% <50 ug/L (95% CI)
National Capital Region			
First district	281	219 (105, 391)	9.1 (6.1–12)
Second district	618	230 (126, 366)	6.2 (4.3–8)
Third district	477	221 (91, 339)	11.2 (8.2–14.1)
Fourth district	529	207 (94, 354)	10.5 (7.9–13.2)
Cordillera Administrative Region			
Abra	168	70 (19, 169)	41.7 (28.8–54.5)
Benguet	306	146 (45, 303)	23.4 (14.2–32.7)
Ifugao	103	105 (39, 231)	25 (16.2–3.9)
Kalinga	138	196 (77, 319)	16.3 (3.1–29.6)
Mountain Province	86	87 (27, 207)	33.6 (12.9–54.4)
Ifugao	63	173 (52, 309)	16.1 (12.8–19.5)
I. Ilocos Region			
Ilocos Norte	172	273 (74, 426)	11.4 (6.6–6.2)
Ilocos Sur	194	161 (57, 286)	18.0 (8.5–27.5)
La Union	178	134 (37, 290)	27.2 (16.2–38.3)
Pangasinan	797	175 (62, 349)	16.5 (12.7–20.4)
II. Cagayan Valley			
Cagayan	330	247 (109, 421)	8.2 (3.3–13)
Isabela	477	219 (96, 378)	10 (6–14)
Nueva Vizcaya	117	141 (55, 310)	17.6 (12.5–22.7)
Quirino	71	259 (110, 444)	13.8 (4.2–23.4)
III. Central Luzon			
Bataan	123	119 (41, 256)	25.5 (18.3–32.6)
Bulacan	485	258 (107, 522)	8.1 (5–11.2)
Nueva Ecija	363	191 (75, 329)	14.1 (9.1–19)
Pampanga	432	218 (102, 408)	7.4 (3.9–10.9)
Tarlac	229	232 (101, 404)	8.7 (4.1–13.4)
Zambales	144	128 (61, 250)	15.8 (6.7–25)
Aurora	42	112 (28, 195)	26.1 (1.1–51.1)
IV-A Calabarzon			
Batangas	350	182 (73, 324)	13 (9.3–16.6)
Cavite	447	274 (113, 410)	8.1 (5–11.2)
Laguna	416	240 (116, 386)	5.8 (2.9–8.6)
Quezon	440	249 (120, 415)	7.1 (3.9–10.3)
Rizal	375	222 (116, 362)	7.3 (4.7–9.9)
IV-B Mimaropa			
Marinduque	102	245 (106, 407)	5.9 (−0.3 to 12)
Occidental Mindoro	183	104 (48, 222)	20.9 (16.3–25.5)
Oriental Mindoro	343	184 (87, 334)	11 (3.6–18.4)
Palawan	307	92 (30, 199)	31.8 (25–38.6)
Romblon	111	145 (59, 238)	19 (9.1– 28.9)
V. Bicol			
Albay	340	145 (37, 307)	24.3 (18.3–30.2)
Camarines Norte	157	154 (59, 304)	18.7 (7.9–29.5)
Camarines Sur	525	167 (62, 306)	16.6 (12.6–20.5)
Catanduanes	62	217 (77, 389)	17.0 (−2.9 to 37)
Masbate	303	138 (65, 224)	17.4 (11.6–23.1)
Sorsorgon	332	145 (57, 309)	17.6 (15.2–19.9)

CI, confidence interval.

Discussion

The aim of this study was to determine the UI levels and prevalence of IDD at the national, regional, and provincial levels based on the median UI of Filipino SAC, 6 to 12 y of age. The last report on the provincial estimates of IDD prevalence was conducted in 1998,

Table 5
Median and prevalence of urinary iodine <50 ug/L among school-age children in the Visayas by province

Region	n	Median (P20, 80) ug/L	% <50 ug/L (95% CI)
VI. Western Visayas			
Aklan	74	148 (58, 253)	17.1 (5.5–28.7)
Antique	110	102 (39, 251)	27 (13.8–40.2)
Capiz	194	99 (22, 304)	33.8 (22.4–45.2)
Iloilo	465	158 (56, 297)	17.7 (12.8–22.5)
Negros Occidental	577	112 (45, 222)	22.7 (18.6–26.9)
Guimaras	44	48 (19, 212)	52.2 (26.7–77.8)
VII. Central Visayas			
Bohol	311	174 (71, 310)	14.6 (8.3–21)
Cebu	874	179 (73, 326)	13.2 (8.9–17.6)
Negros Oriental	300	118 (51, 229)	19.7 (14.7–24.7)
Siquijor	23	187 (103, 299)	6.8 (−3.3 to 18.8)
VIII. Eastern Visayas			
Eastern Samar	153	150 (27, 303)	28.4 (20.5–36.2)
Leyte	524	158 (75, 276)	14.4 (10.7–18.1)
Northern Samar	241	180 (86, 286)	12 (6.4–17.6)
Western Samar	293	167 (76, 297)	12.5 (7.4–17.6)
Southern Leyte	132	155 (68, 334)	14.7 (4.8–24.7)
Biliran	89	145 (46, 225)	20 (11.2–28.8)

CI, confidence interval.

the year when IDD was initially determined based on UI levels. Also, regional estimates have been attempted but the yielded variations demonstrated unreliable results.

UI concentration is used as an indicator of IDD because 90% of ingested iodine is excreted in the urine [12]. Thus, it is considered as a valuable biochemical marker showing the current state of iodine nutrition in a given population.

In this national survey, the median UI level was 168 μg/L, indicating optimal iodine nutrition. According to WHO, ICCIDD, and UNICEF [12], the indicator for iodine deficiency elimination is a median UI of >100 μg/L, and ≤20% of these values should be <50 μg/L. Based on this, the Philippines can be said to have eliminated iodine deficiency because only 16.4% of UI values were <50 μg/L in the surveyed population (Table 2). This result is consistent with the previous national surveys that indicated a sustained elimination of IDD in the Philippines [8,13].

The introduction and implementation of the salt iodization law might have contributed to the reduction of the IDD problem effectively based on a consistent optimum median UI level, which has been clearly recognized since 2003. This is similar with the findings that iodine-deficiency control programs using iodized salt have significantly reduced IDDs. In Enugu State, Nigeria, Nwamarah, et al. [14] reported a median UI value of 124.7 μg/L among children 6 to12 y of age and that 96.2% of the 395 participants had UI between 100 and 199 μg/L. The study also found that 94.2% of the families used iodized salt containing >15 ppm iodine. However, in Limpopo Province, South Africa, the use of iodized salt among families was low and mild iodine deficiency still exists [15].

Studies in Australia and New Zealand likewise recognized the mandatory iodization of salt and fortification of bread in improving the iodine status of children. The median UI of New Zealand children, 8 to 10 y of age, was 116 μg/L and about 5% had values <50 μg/L; whereas in Australia, the median UI among children of the same age group was 183 μg/L [16].

In Mexico and Brazil, the median UI level among SAC were 297 μg/L [17] and 222 μg/L [18], respectively; both in the more than adequate iodine intake status. Like some parts of the Philippines, these two countries should not only focus on areas with iodine deficiency but also monitor and control the rising number of children with iodine intake above the optimum level.

Table 6
Median and prevalence of urinary iodine <50 ug/L among school-age children in Mindanao by province

Region	N	Median (P20, 80) ug/L	% <50 ug/L (95% CI)
IX. Zamboanga Peninsula			
Zamboanga Del Norte	342	41 (14, 101)	55.5 (45.9–65)
Zamboanga Del Sur	494	93 (30, 201)	31.2 (25.2–37.2)
Zamboanga Sibugay	168	71 (22, 166)	40.7 (33.6–47.8)
Isabela City	35	51 (29, 161)	45 (14.8–75.2)
X. Northern Mindanao			
Bukidnon	307	99 (21, 195)	33.3 (26.1–40.4)
Camiguin	38	157 (67, 268)	13.7 (3.2–24.2)
Lanao Del Norte	243	138 (64, 259)	15.1 (7.5–22.6)
Misamis Occidental	170	94 (31, 229)	26.4 (16.5–36.4)
Misamis Oriental	337	145 (49, 290)	20.2 (14.4–26)
XI. Davao Region			
Davao Del Norte	217	147 (48, 264)	21.3 (14.4– 28.2)
Davao Del Sur	549	128 (44, 256)	23.0 (17.7–28.4)
Davao Oriental	159	98 (26, 217)	29.3 (22.5–36.1)
Compostela Valley	165	101 (34, 206)	27.8 (16.2–39.5)
Soccsksargen			
North Cotabato	357	156 (67, 403)	14.4 (8.5–20.3)
South Cotabato	428	117 (31, 253)	26.0 (21–31.1)
Sultan Kudarat	190	124 (40, 234)	24.8 (14.9–34.8)
Sarangani	164	151 (67, 322)	11.9 (4.7–19.1)
Cotabato City	46	149 (65, 278)	14.3 (−1.6 to 30.3)
Caraga			
Agusan Del Norte	265	174 (81, 310)	9.9 (6.9–12.8)
Agusan Del Sur	250	105 (38, 227)	24.9 (16.1–33.7)
Surigao Del Norte	231	127 (71, 212)	16.8 (11.4–22.1)
Surigao Del Sur	293	112 (48, 215)	21.0 (15.7–26.3)
ARMM			
Basilan	82	120 (45, 234)	22.3 (7.6–37)
Lanao Del Sur	355	99 (40, 194)	24.4 (18.1–30.6)
Maguindanao	298	133 (50, 277)	19.9 (15.8–24)
Sulu	146	153 (46, 274)	24.2 (13.1–35.2)
Tawi-Tawi	144	197 (83, 315)	7.7 (3.5–12)

CI, confidence interval; ARMM, Autonomous Region in Muslim Minda.

Table 7
Number and proportion of provinces according to iodine status

Median UIE, ug/L	Iodine status	n	%
<20	Severe iodine deficiency	0	0
20–49	Moderate iodine deficiency	2	2.5
50–99	Mild iodine deficiency	11	13.8
100–199	Adequate	54	67.5
200–299	More than adequate	13	16.3
≥300	Excessive	0	0

UIE, urinary iodine excretion.

The national IDD survey conducted in Malaysia assessed the state of iodine nutrition among children 8 to 10 y of age. However, the disaggregation only included Peninsular Malaysia, Sabah, and Sarawak. These three regions were iodine sufficient based on the indicator set by WHO/ICCIDD/UNICEF. Substantively, the fully gazetted region of Sabah, an area where universal salt iodization was fully implemented, had a median UI level of 150 μg/L compared with Peninsular Malaysia and Sarawak, which had median values of 104 and 102 μg/L, respectively [19].

The present study attempted to estimate the prevalence of IDD on the provincial level. This endeavor enables the local government to install specific and beneficial programs to address IDD.

Based on this study, there are still some provinces that would need extra attention in the implementation of the ASIN Law as a strategy to prevent and control IDD. Monitoring and control of products with iodized salt including iodized water, snack foods, and processed foods should be efficient to ensure that these products reach the areas of concern. Although the iodine status of

Filipino SAC based on the national estimate is at the optimum level, some regions and provinces are still under mild or moderate iodine deficiency. Thus, various multidisciplinary strategies need to be undertaken in strengthening the current approach of combating IDD in the country especially in provinces considered as IDD areas.

Conclusions

The results of this survey imply that the Philippines is successfully reducing the prevalence of IDD. However, deficiency still exists in some provinces. Programmatic strategies to specifically address iodine deficiency in these areas are needed. Convergence of services across all sectors is the key for its successful elimination.

Acknowledgments

The authors acknowledge the Department of Health, Philippines for the financial support extended to establish provincial estimates of IDD. The authors also acknowledge all regional, provincial, and local government officials for their warm hospitality and assistance; the survey team leaders, biochemical researchers, and science aides for their diligence in collecting and safeguarding the samples while in the field; and the laboratory staff for their dedication and perseverance in analyzing the samples. Countless thank you is tendered to all children who participated in the survey.

References

[1] World Health Organization. Iodine status worldwide. WHO global database on iodine deficiency. Geneva, Switzerland, 2004.

[2] Andersson M, Karumbunathan V, Zimmermann MB. Global iodine status in 2011 and trends over the past decade. J Nutr 2012;142:744–50.

[3] Walker SP, Wachs TD, Gardner JM, Lozoff B, Wasserman GA, Pollitt E, et al. Child development: risk factors for adverse outcomes in developing countries. Lancet 2007;369:145–57.

[4] Pearce EN, Caldwell KL. Urinary iodine, thyroid function, and thyroglobulin as biomarkers of iodine status. Am J Clin Nutr 2-16;104(suppl):898 S–901 S.

[5] Zimmermann M. The effects of iodine deficiency in pregnancy and infancy. Paediatr Perinat Epidemiol 2012;26:108–17.

[6] De Benoist B, McLean E, Andersson M, Rogers L. Iodine deficiency in 2007: global progress since 2003. Food Nutr Bull 2008;29:195–202.

[7] Food and Nutrition Research Institute-Department of Science and Technology (FNRI-DOST). Philippine Nutrition Facts and Figures 2001. DOST Complex, FNRI Bldg., Bicutan, Taguig City, Metro Manila, Philippines.

[8] Food and Nutrition Research Institute-Department of Science and Technology (FNRI-DOST). Philippine Nutrition Facts and Figures 2008. DOST Complex, FNRI Bldg., Bicutan, Taguig City, Metro Manila, Philippines.

[9] Pino S, Fang SL, Braverman LE. Ammonium persulfate: a safe alternative oxidizing reagent for measuring urinary iodine. Clin Chem 1996;42:239–43.

[10] WHO/UNICEF/ICCIDD. Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers. 2nd edition Geneva: World Health Organization; 2001.

[11] Andersson M, Zimmermann M. Global iodine nutrition: a remarkable leap forward in the past decade. IDD Newsletter 2012;40.

[12] WHO/UNICEF/ICCIDD. Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers. 3rd edition Geneva: World Health Organization; 2007.

[13] Perlas LA, Marcos JM, Desnacido JA, Serafico ME, Ulanday JRC, Cheong RL. Seventh National Nutrition Survey: iodine deficiency prevalence, trends, and progress towards its elimination. Phil J Nutr 2010;57:33–40.

[14] Nwamarah JU, Olawale O, Olawale OGT, Emewulu CUD. Iodine and nutritional status of primary school children in a Nigerian community Okpuje, in Nsukka LGA, Enugu State, Nigeria. Der Pharmacia Lettre 2015;7:271–80.

[15] Solomon MN, Getrude MX, Pieter JL, Lesly MR, Alphonse AA. Iodine status of rural school children in Vhembe District of Limpopo Province, South Africa. Curr Res Nutr Food Sci 2014;2:98–105.

[16] Jones E, McLean R, Davies B, Hawkins R, Meiklejohn E, Ma ZF, et al. Adequate iodine status in New Zealand School children post-fortification of bread with iodised salt. Nutrients 2016;8:1–9.

[17] García-Solí P, Solís-S JC, García-Gaytán AC, Reyes-Mendoza VA, Robles-Osorio L, Villarreal-Ríos E, et al. Iodine nutrition in elementary state schools of Queretaro, Mexico: correlations between urinary iodine concentration with global nutrition status and social gap index. Arq Bras Endocrinol Metabol 2013;57:473–82.

[18] De Oliveira-Campos R, Reboucas SCL, Beck R, de Jesus LRM, Ramos YR, Barreto IDS, et al. Iodine Nutritional status in schoolchildren from public schools in Brazil: a cross-sectional study exposes association with socioeconomic factors and food insecurity. Thyroid 2016;26:1–8.

[19] Selamat R, Mohamud WNW, Zainuddin AA, Rahim NSCA, Ghaffar SA, Aris T. Iodine deficiency status and iodised salt consumption in Malaysia: findings from a national iodine deficiency disorders survey. Asia Pac J Clin Nutr 2010;19:578–85.