

Iodine Deficiency Disorder Among Filipino School Children, Pregnant and Lactating Women and the Elderly 20 Years After the Act for Salt Iodization Nationwide Law

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Abstract

Background: Iodine deficiency disorder (IDD) is still a public health problem globally. In response to this, universal salt iodization (USI) has been implemented. This is the most cost-effective strategy to prevent and control it. In the Philippines, an Act for Salt Iodization Nationwide (ASIN Law) was passed in 1995, in response to the increasing goiter rates. This paper describes the prevalence and severity of IDD among Filipino school-aged children (SAC), pregnant and lactating women and the elderly, 20 years after the implementation of the ASIN Law.

Methods: Casual urine samples were collected from SAC, pregnant and lactating women and elderly of 1998, 2003, 2008 and 2013, of selected households of the National Nutrition Survey (NNS). Urinary iodine (UI) levels were determined using the acid digestion method. UI levels and prevalence of IDD in the 2013 NNS were compared with those in previous NNSs.

Results: Iodine nutrition among the SAC has improved from mild deficiency with a median of 71 µg/L in 1998 to 201 µg/L in 2003. It has remained “optimal” till the 2013 NNS, almost 20 years after ASIN Law. UI was 107 µg/L among the elderly in 2008, but decreased to 80 µg/L in 2013, also indicating “mild” iodine deficiency. Among the lactating women, UI was 111 µg/L in 2003, indicating iodine sufficiency, but decreased to 81 and 77 µg/L in 2008 and 2013 NNS, respectively, indicating “mild” iodine deficiency. Median UI among the pregnant women was 142, 105 and 105 µg/L, also indicating the presence of IDD for the 2003, 2008 and 2013 NNS, respectively.

Conclusion: Twenty years after ASIN Law, Filipino SAC have

achieved optimum iodine status while the pregnant and lactating women and the elderly remain to be iodine deficient. Strict monitoring of iodization of salt at the production site should be implemented, since iodine levels in salt have remained at levels below the standard.

Keywords: Filipinos; School-aged children; Pregnant; Lactating; Elderly; Iodine deficiency disorder; ASIN Law

Introduction

Universal salt iodization (USI) is the most cost-effective strategy to prevent and control iodine deficiency disorders (IDDs). In the Philippines, in 1995, an Act Promoting Salt Iodization Nationwide and for Related Purposes (ASIN Law) was passed because of the increasing goiter rates [1]. This law requires all salt producers and manufacturers to iodize the salt they manufacture, distribute, trade and/or import.

Globally, the continued decrease in IDD is being attributed to USI. Based on urinary iodine excretion (UIE) levels of school-aged children (SAC) as proxy indicator for the population, the number of iodine deficient countries has decreased from 54 in 2003, to 47 in 2007, 32 in 2011 and 25 in 2014 [2]. Coinciding with the decrease in IDD is the increase in urinary iodine (UI) levels corresponding to excessive iodine intake. There were only five countries with excessive intakes in 2003 and this steadily increased to 12 countries in 2014 [2]. This can happen in countries with chronic iodine deficiency, because there is a rapid increase in iodine intake from iodized salt [3].

Certain Asian countries have attributed improvement of iodine status of their populations to USI. After 10 years of USI in China, iodine nutrition of children 8 - 10 years old improved [4]. In 1995, UIE level was 119.9 µg/L and increased to 191.8 µg/L in 2005. As well, there was a decrease in total goiter rate (TGR) and increase in intelligence quotient (IQ). In Peninsular Malaysia [5], median UI was 82 µg/L in a 1996 survey as compared to 104.1 µg/L 10 years after the implementation of Malaysian Food Act of 1983. The same trend was reported in Bangladesh [6].

Iodine deficiency is the leading cause of preventable mental retardation and impaired psychomotor function in young children. It results in a lower IQ up to 13.5 points below that

Manuscript submitted April 24, 2017, accepted May 12, 2017

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doi: <https://doi.org/10.14740/jem414w>

Table 1. Epidemiological Criteria for Assessment of Iodine Nutrition in a Population Based on Median or Range of Urinary Iodine Concentration in School-Aged Children (≥ 6 Years)*

Median UIE ($\mu\text{g/L}$)	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 of iodine-induced hyperthyroidism in susceptible groups
≥ 300	Excessive	Risk of adverse health consequences

*Applies to adults but not to pregnant women. WHO, UNICEF and ICCIDD, 2001.

of those without IDD. A meta-analysis of 87 studies worldwide showed that iodized salt increases IQ by an average of 8.18 points (97% CI: 6.71 - 9.65) and UI concentration by an average of 59.22 $\mu\text{g/L}$ (95% CI: 50.40 - 68.04) among children [7].

During pregnancy, it increases the risk of still birth and miscarriage. Irreversible impairment of brain development of the fetus occurs if there is iodine deficiency during the second and third trimester of pregnancy. Iodine is necessary for the synthesis of thyroid hormones which is required for the optimal development of the brain. During lactation, iodine deficiency results in low iodine concentrations in breastmilk.

This paper will present results of the series (1998, 2003, 2008 and 2013) of NNS of IDD before and after the implementation of the ASIN Law in 1995. It also aimed to assess the progress towards the elimination of IDD.

Methods

Survey design

The National Nutrition Survey (NNS) of the Philippines is conducted every 5 years by the Food and Nutrition Research Institute of the Department of Science and Technology (FNRI-DOST). The 1998, 2003, 2008 and 2013 NNSs were one-time cross-sectional studies covering all regions of the country. A stratified multi-stage sampling design was used covering 17 regions and the national capital region (NCR). The first stage of sampling was the selection of primary sampling unit (PSU). A PSU is a barangay or contiguous barangays with at least 500 households, then, followed the selection of enumeration areas (EA), a contiguous area in a barangay or a barangay with 150 - 200 households. The final sampling unit was the household.

Urine collection, field storage and transport

In all the surveys, about 15 mL of mid-stream casual urine samples were collected from SAC 6 - 12 years, pregnant and lactating women and the elderly of the selected household. These were kept frozen in the field and while in transport to the

Biochemical Laboratory (BL) of FNRI. At the BL, the urine samples were stored in freezers until determination of UI was conducted.

Determination of UI

UI determination was conducted at the BL of the FNRI-DOST. The acid digestion method of Dunn et al [8] was used to determine UI concentrations. For quality assurance, the BL participates in the Ensuring Quality of Urinary Iodine Procedures (EQUIP) program of CDC, in Atlanta, USA. For precision, a pool of urine is prepared and UI level of the pool, whose concentration was previously determined was analyzed together with the survey samples.

Ethics approval

The conduct of the study was approved by the FNRI Institutional Ethics and Review Committee (FIERC). It was carried out in accordance with the Declaration of Helsinki, guided by the Council for International Organization of Medical Sciences Ethical Guidelines for Biomedical Research involving human subjects [9] and the National Guidelines for Biomedical/Behavioral Research [10]. Only those who signed the informed consent form were included in the study.

Written consent to participate in the eighth NNS was obtained from adult respondents and participants prior to the interview and other measurements. An assent form was accomplished by parents or guardians of children aged 7 years and below. The informed consent and assent forms were translated

Table 2. Epidemiological Criteria for Assessment of Iodine Nutrition in a Population Based on Median or Range of Urinary Iodine Concentration of Pregnant Women

Median UIE ($\mu\text{g/L}$)	Iodine intake
< 150	Insufficient
150 - 249	Adequate
250 - 499	Above requirements
≥ 500	Excessive

WHO, UNICEF and ICCIDD, 2007.

Table 3. Median UIE and Percent Distribution by Age and Physiologic Groups: Philippines, 2013

Age/physiologic group	n	Median (µg/L)	UIE (µg/L)					
			< 20	20 - 49	50 - 99	100 - 199	200 - 299	≥ 300
6 - 12 years	22,588	168	7.7	8.7	14.9	26.6	18.9	23.2
Elderly	3,676	80	15.0	18.7	24.0	27.6	8.9	5.8
Lactating women	1,460	77	15.6	18.6	24.8	26.0	10.3	4.7
		Median	< 20	20 - 49	50 - 149	150 - 249	250 - 499	≥ 500
Pregnant women	1,095	105	11.1	15.9	37.4	20.7	12.1	2.8

into dialects that are most commonly spoken in the Philippines; it explained the background and objectives of the survey, the data collection procedures, involved risks and benefits of participation, confidentiality of information, option to withdraw without penalty or consequences, and the respondent's written consent.

Data analysis and interpretation of results

Descriptive statistics (medians and prevalence of deficiencies) were generated using Statistical Package for the Social Sciences (SPSS) Software, Version 16 (IBM Corp., Armon, NY). Weighting factors were computed and used to generate medians and prevalence rates for the different age and physiologic groups.

The severity of IDD for SAC, elderly, pregnant and lactating women based on median UI concentration was assessed using the epidemiological criteria set by ICCIDD and WHO

[3, 11] shown in Tables 1 and 2.

Results

UI levels were determined as a measure of iodine deficiency in the 1998, 2003, 2008 and 2013 NNSs. According to WHO/ICCIDD/UNICEF [3], the indicator for iodine deficiency elimination is a median UI of more than 100 µg/L, and not more than 20% of these values should be below 50 µg/L.

In 2013, median UI level of the SAC was 168 µg/L (P20-80th, 63 - 322 µg/L) and proportion of UI level < 50 µg/L was < 16.4% (95% CI: 15.7 - 17.1), indicating that iodine nutrition for these groups is optimal (Table 3). This indicates sufficient or adequate iodine intake for the above age groups. On the other hand, median UI level among the elderly was 80 µg/L (P20-80th, 27 - 168) and lactating mothers was 77 µg/L (P20-80th, 31.7 - 36.9), indicating mild iodine deficiency corresponding to insufficient iodine intake. IDD for these groups is a mild

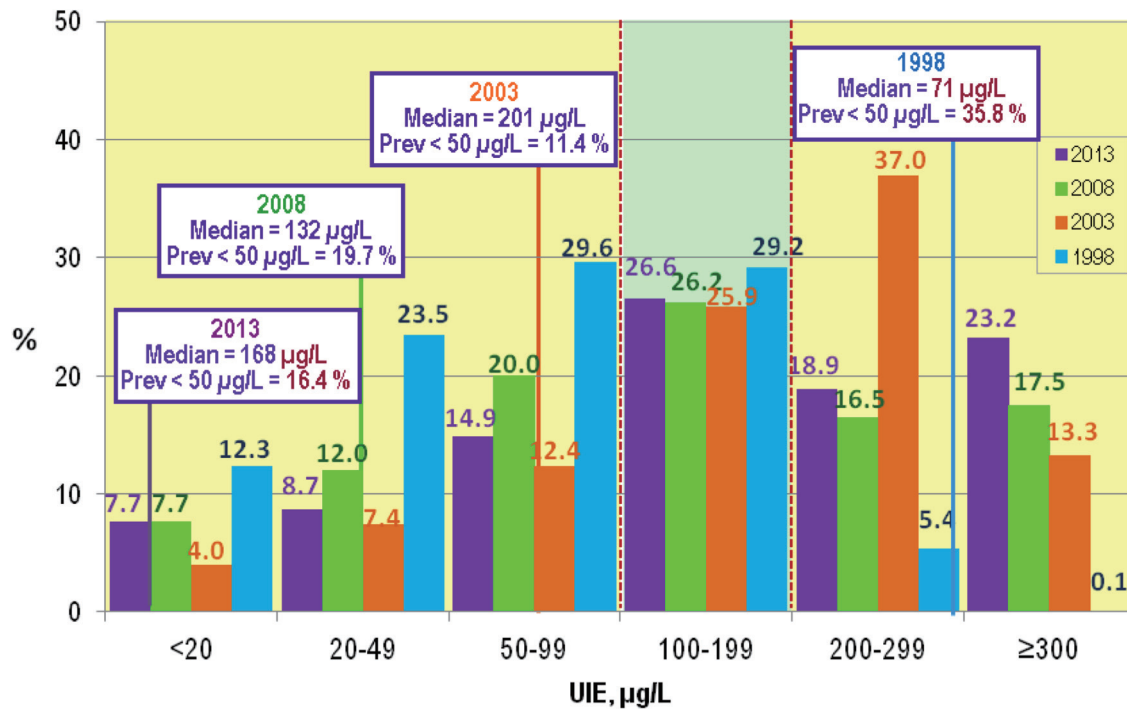


Figure 1. Frequency distribution of UIE values among 6 - 12 years old children, NNS 1998, 2003, 2008 and 2013: Philippines.

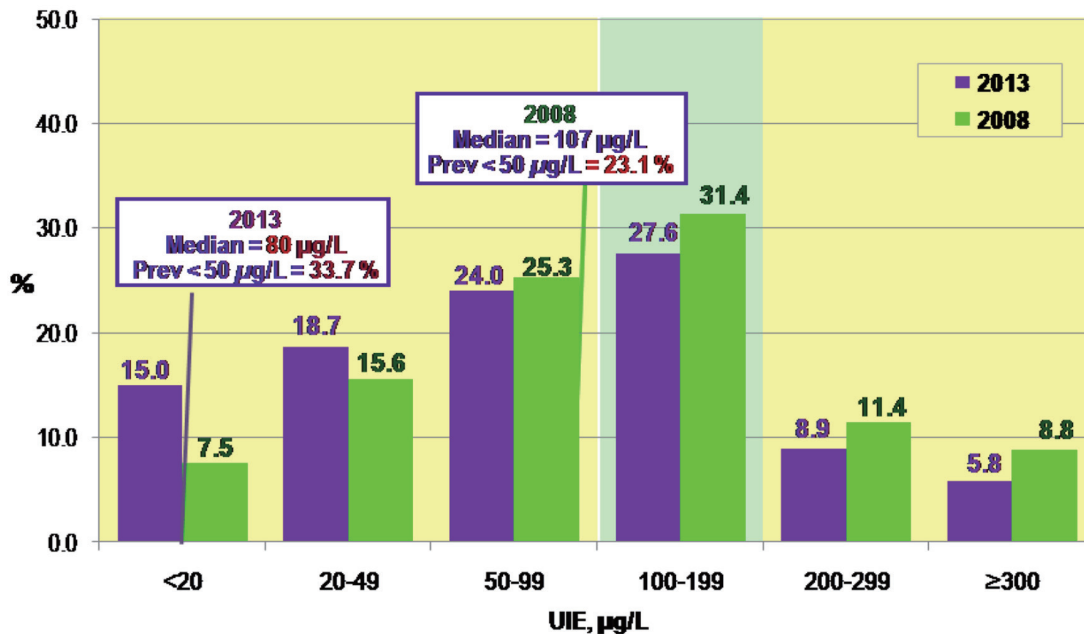


Figure 2. Frequency distribution of UIE values among elderly, NNS 2008 and 2013: Philippines.

public health problem. The cut-off for IDD among pregnant women is 150 µg/L. Thus, the median UI of 105 µg/L (P20-80th, 34 - 213) and the proportion for the pregnant women with UI < 50 µg/L of 27% (95% CI: 24.1 - 29.8) indicate iodine deficiency.

Median UI levels indicating excessive iodine intake (≥ 300 µg/L) were highest among the SAC at 23.2%. Among the pregnant women, median UI levels indicating excessive iodine intake (≥ 500 µg/L) were present in 2.8%.

Trend of IDD among SAC 6 - 12 years old

UI of the SAC was determined in the 1998, 2003, 2008 and 2013 NNSs. Median UI in the 1998 NNS was 71 µg/L corresponding to mild IDD prevalence (Fig. 1). Value < 50 µg/L was 35.8%. In the 2003 NNS, there was a significant increase in the median UI to 201 µg/L, 132 µg/L in 2008, but increased to 168 µg/L in 2013. All the 2003, 2008 and 2013 median levels corresponded to optimum iodine nutrition. Levels < 50 µg/L were 11.4%, 19.7% and 16.4% in 2003, 2008 and 2013 NNS, respectively.

UI levels < 100 µg/L indicating iodine deficiency were 65.4%, 23.8%, 39.7%, and 31.3% for the 1998, 2003, 2008 and 2013, respectively. Excessive level > 300 µg/L was found to have steadily increased from 0.1% 1998 to 23.2% in 2013.

Trend of IDD among the elderly

UI was determined among the elderly only in the 2008 and 2013 NNSs. Median UI was 107 µg/L in 2008 but decreased to 80 µg/L in 2013 (Fig. 2). UI values < 50 µg/L were 23.1% and

33.7% in 2008 and 2013, respectively, indicating the presence of IDD for both surveys. Adequate value was 31.4% in 2008 and decreased to 27.6% in 2013. Values indicating excessive intake was 5.8% and 8.8% for the 2008 and 2013, respectively.

Trend of IDD among lactating mothers

UI of the lactating women was determined in the 2003, 2008 and 2013 NNSs. Median UI was 111 µg/L in 2003 but decreased to 81 µg/L in 2008 which further decreased to 77 µg/L in 2013 (Fig. 3). Both the 2008 and 2013 levels were indicative of insufficient iodine status indicating IDD. UI values < 50 µg/L of 23.7%, 34.0% and 34.2% for 2003, 2008 and 2013 NNS also indicate the presence of IDD, respectively.

UI values corresponding to insufficient (< 100 µg/L) iodine intake among the lactating mothers were 46.4%, 59.5% and 59% for the 2003, 2008 and 2013 NNS series, respectively. Adequate values (100 - 199 µg/L) were 29.1% in 2003, decreasing to 25.7% in 2008 and 26.0% in 2013. Above requirements (200 - 299 µg/L) were 21.1% in 2003, 8.9% in 2008 and 10.3% in 2013. Excessive values (≥ 300 µg/L) were also found; 3.6% in 2003, 5.8% in 2008 and 4.7% in 2013 NNS.

Trend of IDD among the pregnant women

UI of the pregnant women was determined in the 2003, 2008 and 2013 NNSs. Median UI was 142 µg/L in 2003 but decreased to 105 µg/L in 2008 and 2013 (Fig. 4). Both values corresponded to deficient levels (< 150 µg/L) for pregnant women. UI values < 50 µg/L were 18.0% and 25.8% for 2003 and 2008, respectively.

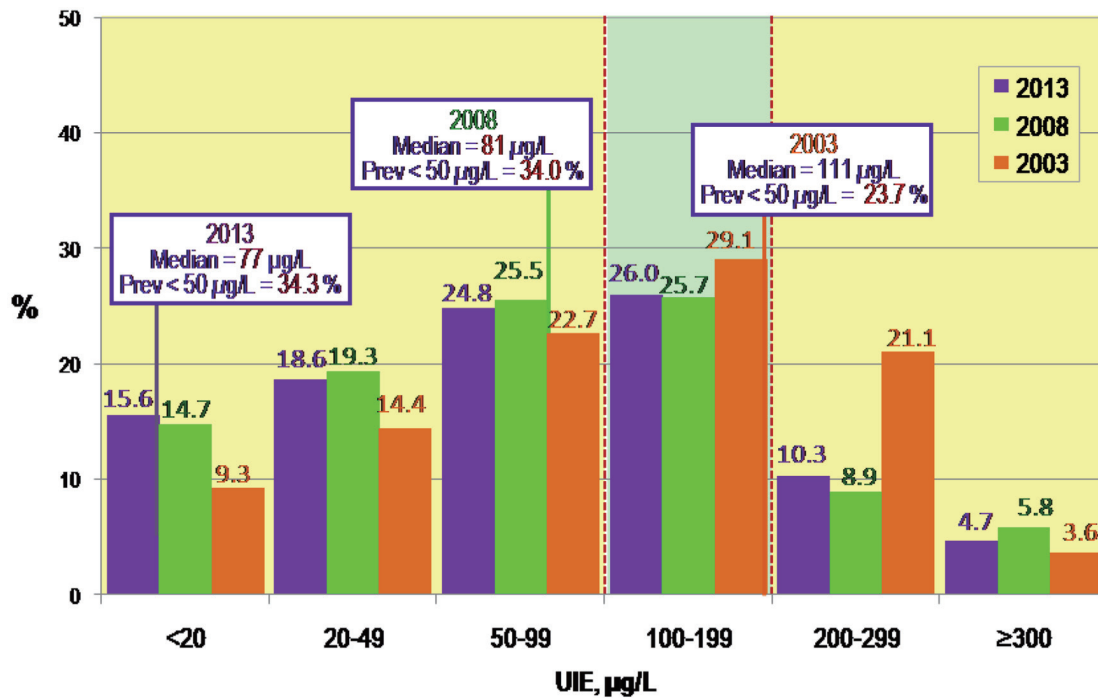


Figure 3. Frequency distribution of UIE values among lactating women, NNS 1998, 2003, 2008 and 2013: Philippines.

UI values (< 150 μg/L) corresponding to insufficient iodine intake among the pregnant women levels were 52.0%, 67.3% and 64.4% for the 2003, 2008 and 2013 NNS series, respectively. Adequate values (150 - 249 μg/L) were 25.4%

in 2003, decreased to 18.1% in 2008 and increased to 20.7% in 2013. Above requirements (250 - 499 μg/L) were 22.5% in 2003, 13.5% in 2008 and 12.1% in 2013. There were no excessive values (> 500 μg/L) in 2003, but excessive values

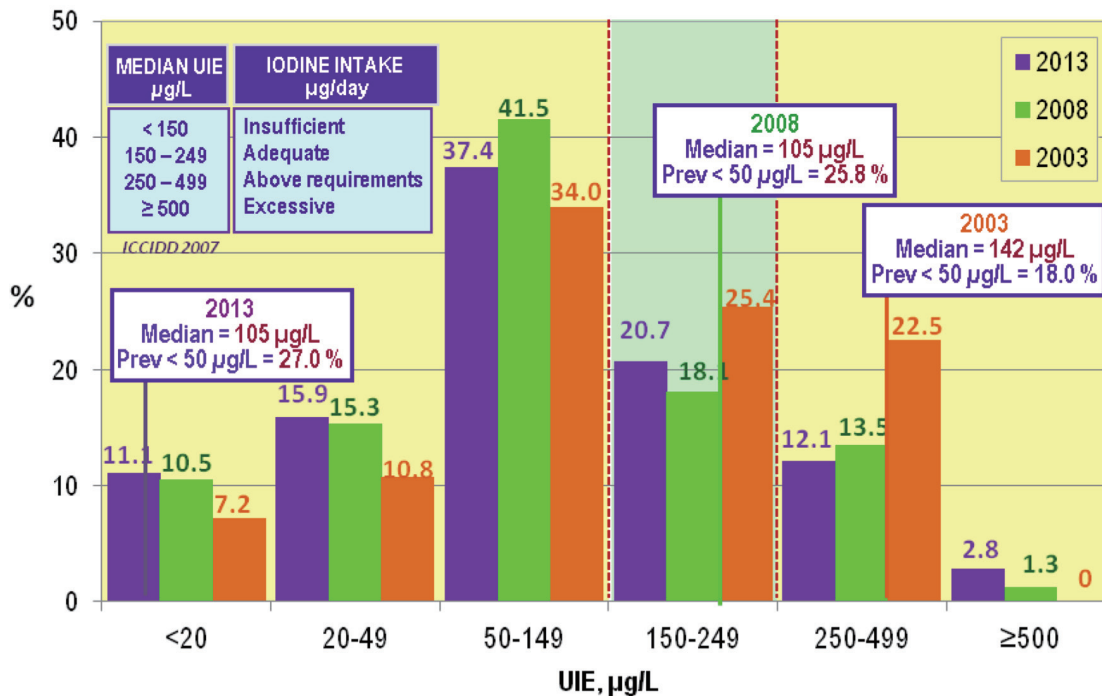


Figure 4. Frequency distribution of UIE values among pregnant women NNS 1998, 2003, 2008 and 2013: Philippines.

Table 4. Progress Towards Elimination of IDD: Philippines 1998 to 2013

Indicator	Goal	Achievements			
		1998	2003	2008	2013
Proportion of households using adequately iodized	> 90	-	-	25.2	25.7
Median UIE, µg/L					
Children, 6 - 12 years	100 - 199	71	201	132	168
Elderly, ≥ 60 years		-	-	107	80
Lactating women		-	111	81	77
Pregnant women	150 - 249	-	142	105	105
Proportion < 50 µg/L, %					
Children, 6 - 12 years	< 20%	35.8	11.4	19.7	16.4
Elderly, ≥ 60 years		-	-	22.3	33.7
Lactating women		-	23.7	34.0	34.2
Pregnant women		-	18.0	25.7	27.0

were found in the 2008 and 2013 NNSs with 1.3% and 2.8%, respectively.

Discussion

The iodine status of SAC is recognized as a proxy of the iodine status of the entire population. However, results of surveys in the Philippines and in other countries prove otherwise. While iodine status of the preschool children has become optimal, the iodine status of the elderly, pregnant and lactating women has remained deficient. A study in China reported that median UI concentration of SAC tends to overestimate that of pregnant women and lactating women, but can be used for assessing iodine nutrition in the adult population [12]. Optimal iodine nutrition in SAC but mild-to-moderate iodine deficiency in their pregnant mothers were also reported in Thailand [13]. These mother-child pairs live in the same household and had meals together.

In a survey in Indonesia, the proportion of households with any iodized salt was high at 91.9%, but the proportion with adequately iodized salt (> 15 ppm) was thought to be low [14]. There was no mention of the actual proportion. Overall, results of the survey show optimum nutrition among the SAC, WRA and pregnant women. However, among the pregnant women, there was still iodine deficiency particularly among those in the lower socio-economic quintiles.

Household coverage of adequately iodized salt was increased by 6.1% (from 46.3% to 52.4%) on average, from 2000 to 2010, in 11 countries that included the Philippines [15]. In 2008, in the Philippines, median iodine content of household iodized salt was 5.28 ppm and only 25.2% of the households surveyed had adequately iodized salt [16].

Progress towards elimination of IDD

The WHO/ICCIDD [3] has set certain indicators for moni-

toring and evaluating IDD control programs. Sustainability indicators include a combination of median UI levels in the population, and availability of adequately iodized salt at the household level.

Since the implementation of the ASIN Law (RA 8172) in 1995 [1], iodine fortification level has been amended twice. The prescribed level of iodine in salt in the original law in 1995 was ≥ 40 ppm at retail. This is higher than the international standard of 15 ppm. Three years after the implementation of the law, the first survey on IDD in 1998 showed median UIE of 71 µg/L and 35.8% had levels < 50 µg/L, among SAC, still indicating “mild IDD” (Fig. 1 and Table 4). Eight years after the implementation of the ASIN Law, in the 2003 NNS, there was a drastic increase in UI among SAC, to 201 µg/L. This level indicates an iodine intake that was “more than adequate”, and it prompted a review of the law and fortification level was decreased in 2007 to 20 - 70 ppm across distribution channels, whether in bulk or retail, imported or local [17]. The decrease in the fortification level could have led to the corresponding lower UIE level of 132 µg/L obtained among SAC in the 2008 NNS. In 2013 [18], fortification level was again revised to 30 - 70 ppm whether in bulk or retail. This optimum level of UIE was maintained in the 2013 NNS.

Similarly in China, the levels of iodine in their salt were also reduced when the medians of UI of SAC, at provincial level, were over 300 µg/L in 18 and 14 provinces in 1997 and 1999, respectively [19]. The initial iodization level was set at 50 mg/kg (50 ppm), in 1995 when USI was first implemented, then later reduced in 2000 to 35 ppm after national monitoring by UI concentration showed this intake to be excessive.

Levels of iodine in iodized salt were determined in the 2008 and 2013 NNSs (Table 4). Proportion of households using adequately iodized salt was 25.2% and 25.7%, respectively for the 2008 and 2013 NNSs. As an indicator for the elimination of IDD, these were below the goal of 90% of households using adequately iodized salt set by WHO/ICCIDD [3]. Results also showed the median iodine in salt was 5.3 and 5.6 ppm, respectively for the 2003 and 2013 NNSs. These results

indicate the poor quality of iodized salt available.

The optimal UI level of SAC, in spite of the below standard concentration of iodine in the iodized salt, implies that there may be other sources of iodine in the diet of this group. Laboratory trials conducted on the retention of iodine in processed foods after cooking and storage showed encouraging results [20]. Substantial amount of iodine was retained in the iodized processed foods after cooking and during 3 months of storage. These processed foods can be good sources of iodine, since these are widely consumed by Filipino households. Iodized cooked processed food products can significantly contribute to the amount of consumption and consequently to the attainment of requirement of iodine.

The elderly, lactating women and pregnant women, may not be consuming enough iodine from other foods outside of that coming from iodized salt to satisfy their requirements. To ensure that optimal iodine nutrition is reached and sustained by all groups, monitoring of both iodized salt and intake of iodine should be done.

Summary and conclusion

Twenty years after the implementation of the ASIN Law, iodine status of SAC, aged 6 - 12 years old, is now optimal although pockets of deficiency still exist. IDD was still seen among the elderly, pregnant and lactating women. UIE levels corresponding to excessive intakes have steadily increased and should be given equal attention as this may cause adverse health consequences such as iodine-induced hyperthyroidism and autoimmune thyroid diseases.

Acknowledgments

Acknowledgement is due to Mr. Glen Melvin P. Gironella for statistical analysis of the data.

Conflicts of Interest

The authors declare no conflicts of interest.

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