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## Iodine deficiency in Benin: Case of pregnant women in the district of Aplahoué in southwestern Benin

G. Abogbo<sup>1,\*</sup>, O. H. Fachinan<sup>2</sup>, G. D. Houndetoungan<sup>1</sup>, D. Sossa Lokossa<sup>1</sup>, B. Awede<sup>3</sup>  
and K. M. Amoussou-Guenou<sup>1</sup>

<sup>1</sup>Biophysics and Nuclear Medicine Teaching and Research Unit, Faculty of Health Sciences, University of Abomey-Calavi, P.O. Box: 188, Cotonou; <sup>2</sup>Nursing and Obstetrics training institute, University of Parakou, P.O. Box: 123, Parakou; <sup>3</sup>Teaching and Research Unit in Human Physiology, Faculty of Health Sciences, University of Abomey-Calavi, P.O. Box: 188, Cotonou, Benin.

### ABSTRACT

Iodine deficiency remains a public health issue worldwide and affects both developed and developing countries. Pregnancy is a risk factor for iodine deficiency in pregnant women due to increased iodine requirements. Therefore, pregnant women are at risk of iodine deficiency even in an area of adequate iodine intake. In Benin, iodine intake is adequate according to the fifth Demographic and Health Survey, although there are pockets of deficiency in some areas. The main objective was to determine the iodine status of pregnant women in the district of Aplahoué in southwestern Benin. This is a cross-sectional, descriptive and analytical study with prospective data collection from November 25, 2018 to July 31, 2019. Urinary iodine assay was performed by the Sandell-Kolthoff method. The average age of pregnant women was 27 years ( $\pm 5$  years) with the extremes of 18 and 45 years. They were mainly multigest (77.74%), multiparous (52.66%) and 17.33% of them had a history of miscarriage. The mean ioduria in pregnant women was 206.33  $\mu\text{g/L}$  ( $\pm 105.74 \mu\text{g/L}$ ). Almost 30% of pregnant women were iodine deficient ( $< 150 \mu\text{g/L}$ ) with 12.67% severe deficiency ( $< 50 \mu\text{g/L}$ ). A correlation was found between the presence of familial goiter, a history of miscarriage and iodine deficiency. Iodine deficiency among

pregnant women is a reality in the district of Aplahoué despite the availability of iodized salt. It is therefore essential to consider iodine supplementation for pregnant women in the district of Aplahoué with risk factors for iodine deficiency.

**KEYWORDS:** iodine deficiency, ioduria, pregnant women.

### INTRODUCTION

Iodine is an essential element in thyroid hormone production. These hormones contribute to psychosomatic growth, cell maturation and brain development processes [1]. Iodine requirements are increased during pregnancy, especially in the first trimester. Prolonged iodine deficiency, even moderate during pregnancy, can induce fetal hypothyroidism that can cause severe neurological and cognitive disorders in children [2, 3]. In addition to fetal development abnormalities, maternal and fetal morbidities linked to maternal hypothyroidism (prematurity, repeated spontaneous miscarriages, fetal death, gestational hypertension and pre-eclampsia) must be added [4]. The natural reserve of iodine is the sea, which contains it abundantly and sufficient for all mankind. It is available in seafood such as fish, crustaceans, algae... [5]. For pregnant women, the World Health Organization (WHO) recommends a daily intake of iodine of 250  $\mu\text{g}$ . A median ioduria between 150 and 249  $\mu\text{g/L}$  indicates an adequate intake [6]. Supported

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\*Corresponding author: abogbogibril@gmail.com

by the initiative of UNICEF, ICCIDD (International Council for the Control of Iodine Deficiency Disorders) and WHO, the goal set by states to end iodine deficiency in the world was ambitious. Over the next ten years, significant progress was noted in terms of the control and promotion of iodized salt, as well as a marked decrease in iodine deficiency [7]. Despite these advances, iodine deficiency remains a public health problem around the world and affects both developed and developing countries. Several recent studies have shown an iodine deficiency in pregnant women even in countries known to be sufficient in iodine [8-10].

In Benin, the Couffo department is an area with adequate iodized salt coverage according to the 5<sup>th</sup> Benin Demographic and Health Survey (EDSBV) with 97.9% of households having iodized salt [11]. Nevertheless, it is reasonable to question whether this coverage was sufficient to cover the iodine needs of pregnant women. It is to answer this question that we undertook this study, the objective of which was to determine the prevalence of iodine deficiency in pregnant women in a district of the Couffo department in Bénin.

## MATERIALS AND METHODS

### Materials

The biological materials used were urine samples collected from pregnant women at the time of the survey and stored at -20 °C. The reagents were made of chloric acid solution used for the digestion of urine, arsenious acid, ceric ammonium sulfate solution, sulfuric acid (catalyst) and standard iodine solution (7.9 µmol/L). The equipment used was: Heating block (110-115 °C), spectrophotometer, ventilated extraction hood with perchloric acid trap, thermometer, test tubes (13 mm x 100 mm), reagent bottles, pipettes, laboratory balance, urine collection and conservation materials (urine jars, freezer, cooler).

### Method

#### • Type and period of study

This was a cross-sectional, descriptive and analytical study with prospective data collection over an eight-month period from November 25, 2018 to July 31, 2019.

#### • Study population and sampling

Covering an area of 915 km<sup>2</sup>, the district of Aplahoué has a population of 171,109 inhabitants. The female population was 91,431. The number of expected pregnancies was 9,109 in 2018 and 9,369 in 2019. Health coverage was provided by eight district health centers and one district hospital.

With an estimate of 35% prevalence, an accuracy of 10% and a confidence level of 95%, the sample size was estimated at 300 pregnant women.

We did a random cluster sampling. Three out of the nine health facilities were drawn with the random number table. The sample size was evenly distributed with 100 pregnant women per health facility. All pregnant women aged at least 18 years who had come for an antenatal consultation at the health facilities concerned at the time of the survey team's visit were systematically included until the expected sample size was reached. The informed consent of all included women was obtained.

#### • Variables studied

Ioduria was the dependent variable. The independent variables were represented by the socio-demographic and clinical characteristics of the pregnant women (age, pregnancy, parity, history of miscarriage, presence of familial goiter, gestational age, thyroid status and the level of consumption of food rich in iodine). Independent variables were collected using a survey form during interviews with pregnant women. Ioduria was determined on the urine samples collected from the interviews using the following method:

**Dosage method:** The method used was that of Sandell-Kolthoff. This was the method recommended by WHO due to ease of implementation and accessibility of reagents [7]. The Sandell-Kolthoff reaction relies on the catalytic role of iodine in the reaction to reduce ceric ions to cerous ions in the presence of arsenic acid. The reaction mixture shows a yellow color at the start, which disappears over time with a rate proportional to the amount of iodine present in the sample (biological, calibrator or control). The absorbance is measured at 405 nm. The decrease in absorbance is proportional to the amount of iodine present in the urine sample.

**Procedure:** The entire procedure was performed in duplicate. For each calibration curve, different

volumes of the standard iodine solution of 1 mg/L (5; 12.5; 37.5 and 75  $\mu$ L) and distilled water were taken directly into tubes with tests (13 x 100 mm) to obtain a final volume of 250  $\mu$ L corresponding to respective iodine concentrations of 20; 50; 150 and 300  $\mu$ g/L (the zero standard consists only of distilled water). Then, to each tube, 750  $\mu$ L of the chloric acid solution was added and vortexed. The mixture was heated for 1 h at 100 °C. After cooling, 3.5 mL of arsenious acid was added and allowed to react for 15 minutes before adding 350  $\mu$ L of the ceric ammonium sulfate solution. To measure the absorbance exactly 20 minutes after the addition of the ceric ammonium sulfate solution, 30 s intervals between procedures were chosen. The wavelength used was 405 nm. The data collected (optical density (Do) and concentration of the corresponding standards) were used to plot the curve of the standards according to a linear regression model. Table 1 and Figure 1 show the data and the curve of the assay standards, respectively (curve plotted according to a linear regression model using Excel 2007 software).

The iodine concentration of each sample is calculated manually after determining the optical densities (Do) under the same conditions as the standards, using the equation:

$Y = -947.32X + 327.38$  (Y = iodine concentration, X = Do).

The reference values used were those of the WHO. A median ioduria between 150 and 249  $\mu$ g/L indicates an adequate intake, while that lower than 150  $\mu$ g/L

indicates an insufficient intake, between 250 and 499  $\mu$ g/L, an intake greater than the normal requirement and greater than 500  $\mu$ g/L, excessive intake [7].

#### • Data analysis

The data were recorded in the Excel 2007 software and processed with the EPI INFO software version 7.1.1.14. The quantitative variables were expressed as means with their standard deviation as well as the extremes. The Chi<sup>2</sup> test was used to answer study questions with a significance level of 5%.

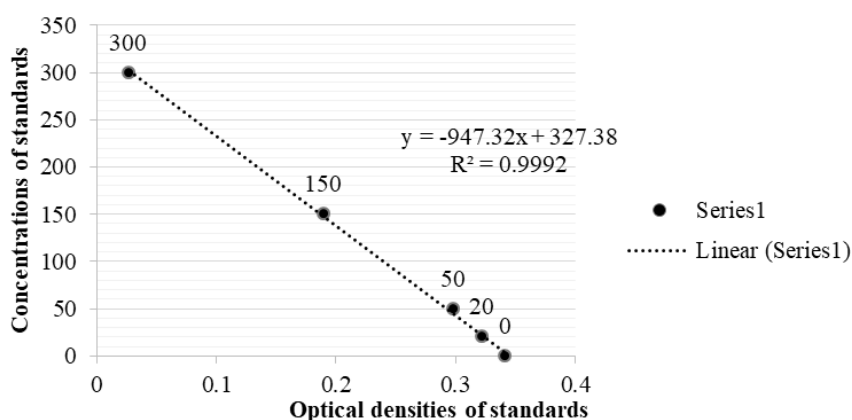
## RESULTS

#### • Sociodemographic and clinical data of pregnant women

The average age of pregnant women was  $27 \pm 5$  years with the extremes of 18 and 45 years. They were mainly multigest (77.74%), multiparous (52.66%)

**Table 1.** Standards and corresponding optical density (Do) (reading with a spectrophotometer in absorbance,  $\lambda = 405$  nm).

Standards	Concentrations ( $\mu$ g/L)	Optical densities
S0	0	0.34
S1	20	0.32
S2	50	0.30
S3	150	0.19
S4	300	0.03



**Figure 1.** Standards curve (plotted using a linear regression model).

and 17.33% of them had a history of miscarriage. Three pregnant women (2.00%) had goiter and 2.67% reported the presence of goiter in their family. The majority of women were seen in the second trimester (52.67%) and in the third trimester (41.33%). Table 2 presents the clinical characteristics of pregnant women. Sixty-six pregnant women ate foods rich in iodine daily, or about one in five pregnant women.

#### • Ioduria in pregnant women

The median ioduria in pregnant women was 232.52 µg/L with the extremes of 15 and 343.48 µg/L. Almost 30% of women were iodine deficient (< 150 µg/L) with 12.67% severe deficiency (< 50 µ/L). About 26% of the women had an adequate iodine intake (150-249 µg/L) and 44.66% an above normal intake (250-499 µg/L). No women had an excessive iodine intake (> 500 µg/L) (Figure 2).

#### • Factors associated with iodine deficiency in pregnant women

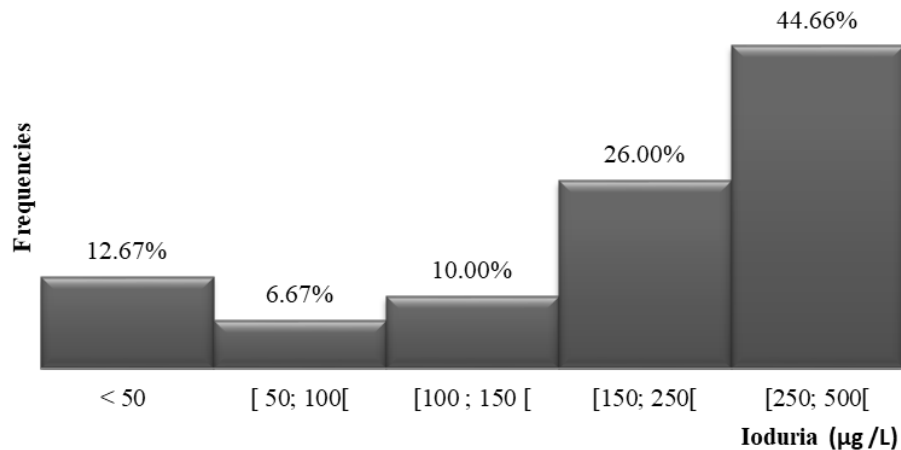
A close correlation was found between a history of miscarriage, the presence of familial goiter, insufficient consumption of foods rich in iodine and iodine deficiency. However, no statistical association was found between occupation, gestational age, parity, gesture and iodine deficiency (Table 3).

## DISCUSSION

The results of our study testify to an adequate iodine intake in pregnant women in the district of Aplahoué. This is in agreement with the Fifth demographic and health survey (EDSBV) which classifies the region as sufficient in iodine with 97.9% of households having iodized salt in 2018 [11]. This result is not far from that of Lean *et al.* in India in 2013 [12]. Agrawal *et al.* also reported a similar result in Nepal in 2013 [13]. However, several authors have reported values significantly lower than ours [14, 15]. More than 70% of pregnant women had an adequate iodine intake (> 150 µg/L). This offered protection to their children who were safe from congenital hypothyroidism. However, not all pregnant women had adequate iodine intake. Almost 30% of them were iodine deficient (ioduria less than 150 µg/L) with 12.67% severe deficiency (<50 µg/L). Similar results have been reported by many authors [13, 16-18]. A high prevalence of iodine deficiency in pregnant women in an area of adequate iodine intake may be explained by the increased iodine requirement during pregnancy [19]. However, other factors could also explain this high prevalence of iodine deficiency among pregnant women in our study population. Indeed, the availability of iodized salt in households is not sufficient on its own to

**Table 2.** Distribution of pregnant women according to their clinical characteristics.

Characteristics	Effective	Percentage (%)
Gesture		
Primigest	68	22.26
Multigest	232	77.74
Parity		
Nulliparous	74	24.67
Primiparous	68	22.67
Multiparous	158	52.66
Number of spontaneous miscarriages		
None	248	86.67
At least one spontaneous miscarriage	52	17.33
<b>Total</b>	<b>300</b>	<b>100.00</b>



**Figure 2.** Distribution of pregnant women according to their ioduria.

**Table 3.** Factors associated with iodine deficiency in pregnant women in univariate analysis.

Variables	Modalities	P-value	RR [IC95%]
History of miscarriage	At least one history of miscarriage	0.01	1.50 [1.01-2.23]
Goitre familial	Presence of goiter in the family	0.04	2.9 [0.52-15.75]
Consumption of foods rich in iodine	less than once a day	0.04	1.27 [1.05-1.54]
Profession	Reseller	0.22	1.14 [0.91-1.41]
	Farmer	0.14	1.2 [0.64-0.94]
Gesture	Multigest	0.46	1.08 [0.87-1.34]
Parity	Multiparous	0.48	0.92 [0.74-1.44]
Gestational age	Second trimester	0.51	1.07 [0.87-1.31]
	Third trimester	0.66	0.95 [0.77-1.17]

ensure an adequate iodine intake for the population. The storage of iodized salts and the method of cooking greatly influence the availability of iodine in dishes [20]. Also, the level of knowledge of the population with regard to iodine deficiency disorders also influences the iodine status of the community. Awareness campaigns are therefore of paramount importance in the fight against iodine deficiency disorders.

A correlation was found between the history of miscarriage ( $p = 0.01$ ), the presence of familial goiter (0.04) and iodine deficiency. A pregnant woman with iodine deficiency is at greater risk of miscarriage than one who has adequate iodized intake. On the other hand, a woman who has a carrier of goiter in her family seems to have a higher risk of developing iodine deficiency. Far

from being exposure factors, these are explanatory factors to be taken into account in assessing the environment of pregnant women with regard to iodine intake for possible supplementation. As with Véronique *et al.*, no statistical link was found between gestational age and iodine deficiency [14]. It was the same for parity, profession and gesture.

## CONCLUSION

This study shows that pregnant women generally have an adequate iodine intake in the district of Aplahoué according to WHO standards. However, the prevalence of iodine deficiency in pregnant women is high. In view of these results, special attention should be paid to their iodine status. This raises the issue of iodine supplementation in pregnant women. However, blind supplementation could

expose some women to iodine overload. It will then be necessary to monitor the iodine status of pregnant women by reconciling supplementation and community screening while taking into account the environmental and dietary factors likely to expose the pregnant woman to iodine deficiency.

#### CONFLICT OF INTEREST STATEMENT

There are no conflicts of interest.

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