**ORIGINAL RESEARCH ARTICLE**

# Urinary iodine concentration and its associations with iodized table salt and thyroid parameters during pregnancy in Algeria

DOI: 10.29063/ajrh2025/v29i8.12

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## Abstract

Iodine is a trace element whose adequate intakes are essential during pregnancy to promote the correct development of the fetus. Iodine excess or deficiency is the cause of several disorders associated with a rise risk of miscarriage or premature birth. The aim of our study was to assess the urinary iodine concentration (UIC) and thyroid function of pregnant women (PW) in northern Algeria. Healthy PW (n=174) were recruited from Gynecology-obstetrics service divided into three group. Spot urine and venous blood samples were collected to assess iodine status through the measurement of urinary iodine concentration, serum thyroid hormones and thyroid peroxidase antibodies concentrations. The relation between thyroid parameters and UIC was studied using correlation analysis. The median UIC values were 246.74 µg/L, 244.68 µg/L and 220,63 µg/L, in the first, second and third trimester respectively. Median TSH and FT4 concentrations were within reference ranges. Among PW, More than 70% of PW, were TPO-Ab+. In northern Algeria, median UICs indicate iodine sufficiency. Monitoring of iodine fortification programs is vital to avoid both iodine deficiency and excess in Algeria. *(Afr J Reprod Health 2025; 29 [8]: 123-130).*

**Keywords:** thyroid; pregnant woman; UIC; iodized salt

## Résumé

L'iode est un oligo-élément dont les apports adéquats sont essentiels pendant la grossesse pour favoriser un développement fœtal normal. La carence en iode est la cause de plusieurs troubles associés à un risque accru de fausse couche ou de naissance prématurée. Le but de cette étude est d'évaluer la concentration en iode urinaire (CIU) et la fonction thyroïdienne dans le nord de l'Algérie. Des femmes enceintes (FE) en bonne santé (n=173) ont été recrutés dans le service de gynécologie-obstétrique et répartis en trois groupes. Des échantillons d'urine et de sang veineux ont été prélevés pour évaluer le statut iodé. Une analyse de corrélation a permis étudier l'association entre la CIU et les paramètres thyroïdiens. La CIU étaient de 246,74 µg/L, 244,68 µg/L et 220,63 µg/L, respectivement au premier, deuxième et troisième trimestre. Les concentrations en TSH et de FT4 étaient comprises dans des normes. Plus de 70% des FE avaient des anticorps anti TPO+. Dans le nord de l'Algérie, les concentrations médianes en iode urinaires indiquent une suffisance d'iode. La surveillance des programmes d'enrichissement en iode est essentielle pour éviter à la fois la carence et l'excès d'iode en Algérie. *(Afr J Reprod Health 2025; 29 [8]: 123-130).*

**Mots-clés**: Thyroïde; femmes enceintes; CIU; sel iodé

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## Introduction

Iodine is an essential micronutrient relatively abundant in the aquatic environment; the oceanic space constitutes the major reserve compartment of iodine with a content of 45-60 µg / L mainly in iodate and iodide form.[1] Iodine is also important for the synthesis of thyroid hormones, which are essential for the performance of many vital functions of the organism, such as regulation of basic metabolism, reproductive function including the development of the neurological system throughout pregnancy.[2] A normal adult in the reproductive age range requires about 150 µg of iodine per day; during pregnancy, this requirement rises to 200–250 µg.[3] Median urine iodine concentrations have been used frequently as a biomarker of population iodine intake besides thyroglobulin with levels of UIC < 150µg/L

considered low in pregnant women and >500 µg/L considered excessive in pregnant women.[4,5]
Iodine deficiency during pregnancy is the cause of several disorders in fetal development wich can result in impaired fetal neurocognitive developmental defects such as cretinism.[2,6] Therefore, an adequate iodine intake during pregnancy is essential for normal development of the fetus.

Iodine deficiency persists in some regions of Algeria, it has been previously estimated at 30–70%. In the northern rural and mountain regions.[7] Even after the addition of iodized salt to food in 1990.[8] This is because its iodine level is not able to be routinely measured. According to WHO,[9] only 60.7% of households in Algeria use iodized salt with an inadequate intake of iodine (27µg /L).[9] In 2016, a study conducted during pregnancy, revealed a median of 180µg /L; other studies, indicated a median of 227µg/L to a normal consumption of iodine.[10,11] In addition, no longitudinal study concerning the association between UIC, iodine in salt and thyroid parameters during prenancy has been conducted before in the country. The purpose of our study is the assessment of the iodine status, the correlation between iodine nutrition and the analyze of potassium iodate contents in some salt consumed by pregnant women in Algeria.

# Methods

## *Study population and samples*

This cross-sectional study enrolled 174 pregnant women who visited the Bologhine (Gynecology-obstetrics service, Public Hospital Etablishment Ibn Ziri, Algiers) in 2021 with mean age of 31,03 ± 0,38 years. Pregnant women were divided into three groups: 1st (n=23), 2nd (n=61) and 3rd trimester of pregancy (n=90).

Pregnant women with thyroid disorder or other chronic diseases and those who had supplemented iodine during pregnancy were not included in this study. All participants provided their informed consent. The study was approved by the ethical review committee in the hospital of Bologhine IBN ZIRI in Algeria on September 23, 2019 with reference number: CEB001904 in accordance with the MMA's declaration of Helsinki on ethical principles for medical research involving humans.

Morning Spot urine samples were obtained and maintained at −20 °C until analysis for UIC at the Human Nutrition Laboratory (ETH Zürich, Switzerland), using a modified Sandell-Kolthoff method at 405 nm.[12] The WHO guidelines (median UIC: 150–249 µg/L among pregnant women) were utilized to determine iodine sufficiency.[6] Venous blood was collected from each pregnant women for the analysis of thyroid parameters in the Laboratory of Analysis of Endocrinology, EPH Bologhine.
Radioimmunometric assays (IRMA) was used to analyze blood TSH and Tg (IM3712, Immunotech Inc., Beckman Coulter, France; A85726, Cis Bio Bioassays, France). The radioimmunologic method (RIA) was used to determine the serum FT4 and TPO-Ab concentrations (IM1363, IM3321 for FT4 and A56719 for TPO-Ab assays, respectively, Immunotech Inc. Beckman Coulter, France).

The potassium iodate content of Algerian iodized salt was analysed using the iodometric method published in the Official Journal of the People's Democratic Republic of Algeria in the Physico-Chemical Laboratory (Saidal Pharmal Unit, Algeria) on the requirement to use iodometric method for determination of iodine content in food salt.[13] Potassium Iodate ($KIO^3$) and Potassium Iodide (KI) were provided by Sigma Aldrich (Germany).

## *Statistical analysis*

Statistical analysis was performed using the R Project for Statistical Computing. The Shapiro–Wilk test was used to detect a normal distribution data. Continuous variables were presented as mean ± standard deviation (SD) or median (interquartile range, IQR). The Kruskal-Wallis test were performed for comparisons of UIC and thyroid parameters between trimester. Spearman's method was conducted for correlation analysis of UIC and other variables. The level of significance was $P < 0.05$

# Results

## *Urinary iodine concentration (UIC) and potassium iodate (mg/kg) content in table salts*

Adequate iodine intake (150-249µg/L) was found durnig pregnancy (232.6µg/L) with 27, 36 and 32% of PW during the first, second and third trimesters of pregnancy respectively (Figure 1).

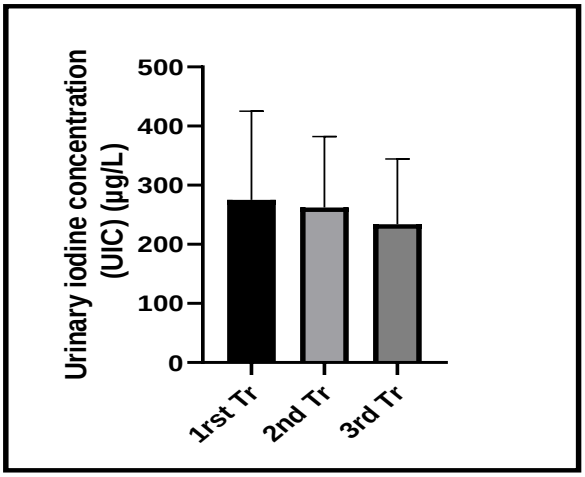


**Figure 1:** Urinary iodine concentration (UIC) during pregnancy in Algeria .**Tr**: Trimester of pregnancy

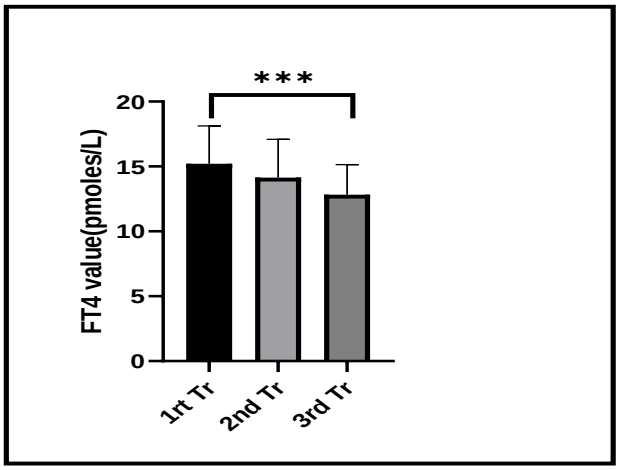


**Figure 3:** Free T4 (FT4) concentrations during pregnancy in Algeria. **Tr**: Trimester of pregnancy

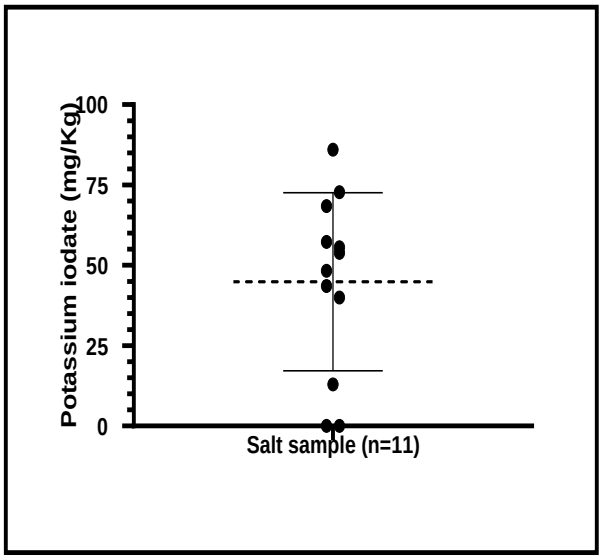


**Figure 2:** Iodine content (mg/kg) in table salts marketed in Algeria (***n*** = 11) represented by green dotted lines

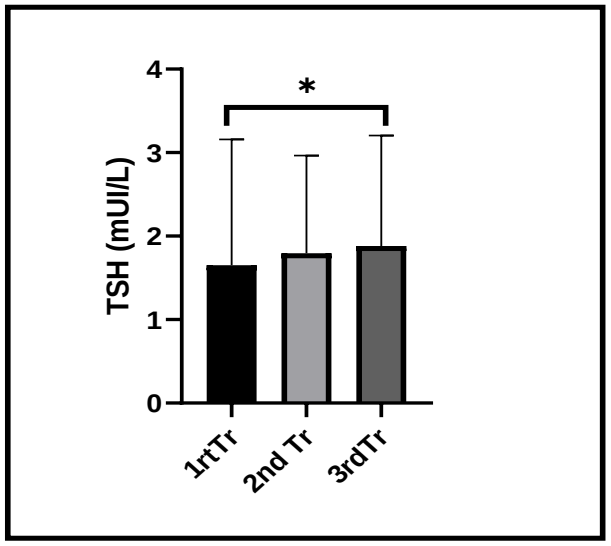


**Figure 4:** TSH levels during pregnancy. **Tr**: Trimester of pregnancy

The population of pregnant women shows variations in ioduria with a gradual decrease during the three trimesters with median UIC values of 246.74 µg/L, 244.68 µg/L and 220,63 µg/L respectively. The proportions of PW with UIC values below 150µg/L were 23, 15 and 24% respectively for the 3 trimester of pregnancy. Pregnant women who consumed more than the recommended amount of iodine (250–499 µg/L) were likely to have higher proportions (> 40% per trimester), whereas 4% of PW had excessive UIC values (> 500 µg/L).

excessive UIC values (> 500 µg/L).

Analysis of the potassium iodate content on 11 samples of table salt marketed in Algeria, showed that only 42% were samples analyzed respected the Algerian recommendation regarding iodine content in table salts (50.55–84.25 mg/k of salt) for the prevention of iodine deficiency disorders (IDD) compulsory by an executive decree. The amount of potassium iodate in salt must be for: Potassium iodate (67.40 mg/kg) of 50.55 mg/kg < 67.40 mg/kg < 84.25mg/kg (Figure 2).

**Table 1:** thyroid parameters in pregnant women from Algiers

| | 1st Tr n= 22 | 2nd Tr n= 61 | 3rd Tr n= 90 | Comparing the group means | p values |
|---|---|---|---|---|---|
| FT4 (pmol/L) | 15,21± 0,62 | 14,14 ± 0,38 | 12,82 ± 0,24 | 1st Tr/2nd Tr | 0,07 |
| | | | | 2nd Tr/3rd Tr | 0,345 |
| | | | | 1st Tr/3rd Tr | 0,00095*** |
| TSH (mUI/L) | 1,65 ± 0,32 | 1,79 ± 0,15 | 1,88 ± 0,14 | 1st Tr/2nd Tr | 0,27 |
| | | | | 2nd Tr/3rd Tr | 0,87 |
| | | | | 1st Tr/3rd Tr | 0,048 |
| Tg (µg/L) | 12,19 ± 1,83 | 14,52 ± 2,93 | 12,45 ± 1,10 | 1st Tr/2nd Tr | 1 |
| | | | | 2nd Tr/3rd Tr | 1 |
| | | | | 1st Tr/3rd Tr | 0,8295 |
| TPO antibodies (U/mL) | 25,96 ± 8,52 | 21,61 ± 3,91 | 38,25 ± 14,56 | 1st Tr/2nd Tr | 0,829 |
| | | | | 2nd Tr/3rd Tr | 0,999 |
| | | | | 1st Tr/3rd Tr | 0,0038** |

The study showed that only 76%, 78% and 80% respectively of pregnant women with normal UIC consumed sufficiently iodized salt, 17%, 12% and 15% respectively of pregnant women consumed low-iodine salt wich represent 50% from analyzed samples, Only 7%, 8% and 5% of pregnant women respectively in 1st, 2nd and the 3rd trimester of pregnancy, consumed iodized salt whose potassium iodate analysis had indicated a higher potassium iodate level than required.

### *Assessment of associations among different parameters (UIC and thyroid parameters)*

Pregnancy is associated with a decrease in the mean serum values of FT4 (Figure 3) (Table 1). It was estimated to 15,21± 0,62 pmoles/L in the first trimester, 14,14 ± 0,38 pmoles/L in the second trimester and 12,82 ± 0,24 pmoles/L during the third trimester of pergnancy.

There is a statistically significant difference ($p<0,001$) between the first and third trimesters of pregnancy. TSH averages, on the other hand, rise throughout pregnancy (Figure 4) (Table 1).

TSH level was estimated to 1,65 ± 0,32mUI/L in the first trimester, 1,79 ± 0,15mUI/L in the second trimester and 1,88 ± 0,14mUI/L during the third trimester of pregnancy. No statistical difference has been observed between different groups (Figure 4).

Thyroglobulin is considered as a biomarker of iodine deficiency; serum Tg levels are included in the norms and show no statistically significant variations between them (Table 1). More than 70% of women were positive TPO-Ab during pregnancy. In the PW with positives TPO antibody, there is a negative non significant correlation between the TSH levels with FT4 (r= - 0,101 ; p=0,690) and UIC (r= - 0,277 ; p=0,266). However, a significant positive correlation is also noted in the Tr1 of pregnancy between TPO antibody titers and circulating TSH levels (r= 0,586 ; p= 0,011). In the second trimester, a positive significant correlation were observed between UIC and week of pregnancy (r= 0,309 ; p =0,037) and between Tg and FT4 levels (r= 0,429 ; p= 0,003). Analysis of linear regression conducted during the third trimester, revealed an important negative association between urine iodine concentrations and levels of TPO antibodies (r= -0,247 ; p= 0,042) and a significant positive correlation between serum Tg values and Tr of pregnancy (r=0,243 ; p=0,046). Conversely, a highly significant negative association is observed between the serum concentrations of Tg and TPO antibodies (r= -0,460 ; $p = 7,96\ 10^{-5}$).

## Discussion

In our study, the median values of the UIC in pregnant women indicate optimal iodine intakes during all the pregnancy with the proportions with adequate iodine intake (150 - 249 µg/L) of 27%, 36% and 32% during pregnancy and 76%, 78% and 80% respectively of pregnant women consumed sufficiently iodized salt.[9] Several study reported a decline in UIC during pregnancy.[13-15]

In our study, 23%, 15% and 24% of PW had UIC values under 150 µg/L while 41%, 43% and 40% had more than adequate iodine intake

respectively for the three trimesters. This decrease may indicate that iodine storage has been depleted as a result of renal excretion, nutritional insufficiency, or consumption by the maternal-fetal unit or to meet the increase in thyroid hormone requirement induced by pregnancy.[16,17] The decrease in iodine concentration under 150 µg/L may be explained by the difference in salt quality and potassium iodine content consumed by pregnant women and that potassium iodine content in table salt, presents differences between the samples analysed. Additionally, due to the population's fish-eating habits and considering that Algeria's coastal areas are relatively proximity to the sea and because iodine status has been irregularly monitored.[16]

Beside UIC, 90% of ingested iodine is excreted in the urine, a various other indicators which are used in monitoring and evaluating IDD control programmes, such as thyroid volume, hormone (TSH, T4) and thyroglobulin (Tg).[4,5] According to Glinoer *et al*,[16,37] there is an increase in renal iodine excretion during the early stages of pregnancy due to the higher iodine needs, which as shown in our study results to an increase in maternal T4 production to ensure a transfer of thyroid hormones to the fetus and maintain a state of maternal euthyroidism, during which the fetal thyroid gland is not yet functional.[18,19]

Level of FT4 decrease between the first and second trimester. A similar decrease has been reported by other studies.[20,21] In order to maintain adequate maternal levels of free T4 and T3, the production of thyroids hormones increases by about 50% during pregnancy. The decrease in circulating FT4 levels in pregnant women in our study, could be explained by the fact that the fetal thyroid gland is not functionally mature before the 18$^{th}$-20$^{th}$ week of pregnancy. T4 is the main thyroid hormone transferred through the placenta. On the other hand, increased estrogen concentrations during pregnancy induce an increase in hepatic synthesis and sialylation of TBG, Thus decreasing its metabolic clearance. This results in a double increase in serum TBG and total T4 and T3, resulting in a transient decrease in free serum T4 and T3 throughout pregnancy. Thus, free T4 concentrations remain normal or decrease slightly.[22]

Additionally, placental desiodinase D3 activity has risen throughout pregnancy in order to recycle iodine and control the levels of active hormones in fetal blood. On the other hand, hCG would have a stimulatory effect on the transfer of iodine through the placenta (cytotrophoblastic cells) from the mother to the fetal compartment, notably by a transcriptional and translational effect of the sodium-iodide carrier gene (NIS) at the placental level.[23]

Insufficient iodine intake leads to a shift towards increased preferential thyroid production of T3 and reduced production of T4 in order to save iodine. This can lead to low levels of T4 and FT4, while TSH concentrations were maintained at normal values due to the persistent negative feedback of T3. This adaptation can be beneficial for the mother; however, since T4 is the main thyroid hormone that crosses the placenta, maternal hormone thyroid supply to the fetus may be compromised.[19,24,35] Several studies have described the consequences of maternal iodine deficiency and maternal thyroid dysfunction in both mother and fetus.[25] Therefore, iodine supplementation is necessary during pregnancy to provide a supply for the mother and fetus [24].

In our study, the mean serum TSH concentration of pregnant women increased gradually from the first to the third trimester, with a significant difference between ($p=0.048$). Lower serum TSH levels in the 1$^{st}$ trimester could be explained by the rise level of chorionic gonadotropin (hCG) secreted by syncytiotrophoblasts cells, which stimulates the corpus luteum to produce progesterone, essential for maintaining pregnancy. hCG has thyrotropic effects and has structural similarities with TSH leading to an increase in the first trimester of thyroid hormones and a concomitant suppression of circulating TSH. It has been suggested that such a mechanism of regulation of the foetus-maternal endocrine system allows, in early pregnancy, to keep sufficient concentrations of thyroid hormones necessary for fetal development since its thyroid gland still does not have the ability to synthesize its own hormones thyroid.[18]

Our study showed normal serum thyroglobulin (Tg) levels. However, studies reporting the relationship between serum thyroglobulin levels and iodine intakes in pregnant women are rare and no international reference is available. The few published data suggest that

thyroglobulin could be slightly elevated during pregnancy in iodine-deficient pregnant women due to increased thyroid activity.[27]

In our study, the proportions of positive TPO antibody titers. Autoimmune thyroid diseases usually regress during pregnancy due to pregnancy-induced immunosuppression.[28,29] Mechanisms that trigger the development of abnormal immune response and the relationship of autoimmune thyroid diseases with excess iodine are still poorly understood and that an increase in thyroglobulin (Tg) iodization increases its immunogenicity and promotes oxidative damage.[30-32]

The study of linear regression with positive TPO antibodies showed a high association between TSH levels and positive TPO antibodies in the first trimester of pregnancy. This finding corresponds with the hypothesis that elevated TPO antibodies would predict subclinical hypothyroidism in pregnant mothers as indicated by TSH levels.[33]

In the second trimester, a positive correlation was observed between the weeks of pregnancy and UIC due to increased glomerular filtration during pregnancy.[34,35] A very significant correlation is also observed between the levels of FT4 and thyroglobulin. This association could be a reflection of an increased activity of the maternal thyroid gland to meet the needs of the fetus whose thyroid gland is non-functional before the 20$^{th}$ week of pregnancy.[36]

During the last trimester, the weeks of pregnancy were positively correlated with serum thyroglobulin levels. According to Glinoer *et al*,[16] high serum thyroglobulin concentrations reflect a change in the anatomical structure of the thyroid and could be a marker for increased thyroid volume.[37] Thyroglobulin elevation during the third trimester of pregnancy is also observed in other studies.[38,39] Although thyroglobulin is an indicator of iodine deficiency and excess in a population, these results suggest that the increase in serum Tg concentration during pregnancy is mainly caused by increased thyroid secretion due to increased thyroid activity independently of iodine deficiency.[18,40,41]

The analysis of our finding in the 3$^{rd}$ trimester of their pregnancy, showed that circulating levels of Tg are strongly correlated with TPO antibody titers ($p=7.96\ 10^{-5}$), due to the fact that the majority of pregnant women were in euthyroidism and positive for TPO antibodies indicating an Autoimmune thyroid diseases, most likely during installation, with a high predisposition to functional alterations of the gland during pregnancy or postpartum.[42,43]

Analysis of the potassium iodate content of table salt marketed in Algeria showed that only 42% of the iodized salt analyzed were conform to the Algerian recommendation regarding iodine content in table salts (50.55–84.25 mg/k of salt) for the prevention of iodine deficiency disorders (IDD) compulsory by an executive decree.[43]

More than 70% of pregnant women with normal UIC, consumed sufficiently iodized salt. Our findings are similar to Guerras' findings, which indicate that only 17,65% of the samples collected throughout the country conformed to the requirements established in the decree, compared to 57.35% and 11.76%, respectively, for samples with low contents (<50.55 mg $KIO^3$/kg) and elevated contents (>84.25 mg $KIO^3$/kg).[45] Iodization in the Algiers region had been found to be more adequate than in the regions of Batna, Biskra, M'sila, and Bordj Bou Arreridj, according to a comparison of iodine levels in samples obtained from these regions. This might be the result of the way salt is stored to prevent iodization, how salt is sold retail, and the sort of packaging that the salt is packaged in to influence its iodine level. It would appear that this deficiency persists in both mountainous and coastal regions since 17%, 12% and 15% respectively of pregnant women consumed low-iodine salt.

## Conclusion

In conclusion. More than 40% of pregnant had more than adequate iodine intake during pregnancy, with normal thyroid function in Algiers. Linear regression analysis conducted in pregnant women, showed an association between UIC and thyroid parameters. In Algeria, the use of salt iodine supplements appears to have been successful in reducing iodine deficient disorders over the past decade. Nevertheless, iodine excess, brought on by exposure to the environment and/or eating foods, is currently more common than iodine deficiency and is what causes thyroid disorders in both the mother and the fetus. In order to assess iodine intakes and improve the efficacy of iodine prophylaxis, it would be important to measure the amount of iodine consumed and to regularly perform national surveys.

## Statement of ethics

This study was conducted with ethical approval from Public Health Establishment‘ services in accordance with the MMA’s declaration of Helsinki on ethical principles for medical research involving humans (committee name: Bologhine Hospital Ethics Committee from Public Health Establishment Ibnziri Bologhine, reference number: CEB001904). Written informed consent was obtained for participation in this study.

## Acknowledgements

We thank the health professionals at the Public Hospital Establishment Ibn Ziri in Bologhine, Algiers, who recruited subjects for this study, as well as the staff of Laboratory BPO/Endocrinology of the Faculty of Biological Sciences, USTHB, and the Endocrinology Department, Hôpital Bologhine, Algeria. We also want to thank Christophe Zeder from the ETH Zurich Human Nutrition Laboratory in Switzerland. Every author helped evaluate the results and write the manuscript.

## Conflicts of interest

The authors declare that they have no conflicts of interest.

## Funding

This study was supported by funding from the Ministry of Health for the Public Hospital Establishment Ibn Ziri, Bologhine, Algiers and the Ministry of Higher Education and Scientific Research for the Laboratory BPO/ Section Endocrinology of the Faculty of Biological Sciences, USTHB (16/2021-D/SB) and Algeria.

## Authors contributions

Participated in research design: Z Hamouli-Said, Dj Meskine, MB Zimermann and A Kamel.
Performed and conducted experiments: Z Hamouli-Said, H Kherrab and L Lakabi, Dj Meskine.
Performed data analysis: MB Zimmermann.
Final approved of the version to publish: Z Hamouli-Said, Dj Meskine and MB Zimmermann

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