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Short Communication

Inadequate status of iodine nutrition among pregnant women residing in three districts of Niamey, the Niger Republic's capital

Hassimi Sadou[†], Amina Seyfoulaye[*], Mousbahou Malam Alma[†] and Hamani Daouda[*]

[*]*Laboratoire de Biochimie, Faculté des Sciences de la Santé, Université Abdou Moumouni, Niamey, Niger, and* [†]*Laboratoire de Nutrition Humaine, Faculté des Sciences et Techniques, Université Abdou Moumouni, Niamey, Niger*

Abstract

Universal dietary salt iodisation (UDSI) programme was implemented in Niger in 1996. However, since 2000, there has been a slowdown in progress against iodine deficiency. The aim of our study was to assess the iodine status among pregnant women in a context where national controls are not effective at ensuring universal availability of adequately iodised salt. This is mainly to assess the impact of the slowdown in the fight against iodine deficiency in this vulnerable group. The study was centred on 240 healthy pregnant women volunteers recruited in three districts primary health centres. A control group of 60 non-pregnant, non-lactating healthy women was also studied and compared. Median urinary iodine concentration (UIC) of all pregnant women was 119 $\mu g\ L^{-1}$, and 61.67% had UIC below 150 $\mu g\ L^{-1}$. Median UIC for the first, second and third trimester were 144, 108 and 92 $\mu g\ L^{-1}$, respectively. The percentage of pregnant women with UIC below 150 $\mu g\ L^{-1}$ increased from 52% in the first trimester to 66% in the third trimester. The median UIC of the control group was 166 $\mu g\ L^{-1}$, and 28.33% had UIC below 100 $\mu g\ L^{-1}$. No significant relationship was found between nutritional iodine status and provenance, age and parity. However, significant relationship was found between iodine status and stage of pregnancy, gestational age and educational level ($P < 0.05$). Iodine nutrition status thus observed was inadequate in 61.67% of all the pregnant women. It is therefore urgent to revitalise implementation of the UDSI programme, and in the short term to consider iodine supplementation for pregnant women.

Keywords: iodisation, iodine status, pregnancy, pregnant women, urinary iodine, Niger.

Correspondence: Professor Hassimi Sadou, Laboratoire de Nutrition Humaine, Faculté des Sciences et Techniques, Université Abdou Moumouni, BP 10662 Niamey, Niger. E-mail: hassimi@yahoo.com

Introduction

Iodine deficiency in human diet is responsible of various pathologies commonly called iodine deficiency disorders (IDDs) (Hetzel 1994; Dunn 2006; WHO *et al*. 2007; Zimmermann *et al*. 2008). The first national survey on IDD conducted in 1994, in schools, showed that Niger was among the countries south of Sahara affected by iodine deficiency and related pathologies. This survey was centred on 8933 schoolchildren aged 10–15 years. The total goitre rate was 35.8% and the visible goitre rate was 5.7%. Urinary iodine (UI) from 795 pupils gave a median of 34 $\mu g\ L^{-1}$, and about 90% of pupils tested had UI concentration (UIC) below 100 $\mu g\ L^{-1}$, which is defined as optimal (International Council for Control of Iodine Deficiency Disorders 2002; WHO *et al*. 2007). In 1996, universal dietary salt iodisation (UDSI) was adopted by Niger as a strategy for prevention, control and elimination of iodine deficiency. Thus, the production, importation, distribution and marketing of dietary iodised salt were made mandatory by an inter-ministerial act in October 1995, which came into force on 1 April 1996 (République du Niger 1995). A system of quality control of dietary iodised salt was introduced, strengthened by devices at the customs offices, distribution channels and sales.

A 1998 survey 2 years after the introduction of iodised salt assessed 944 pupils from 237 primary schools in eight regions of the country. The results obtained indicated that the use of iodised salt led to an increase in iodine content of the urine. Thus, the median UIC increased from 34 $\mu g\,L^{-1}$ in 1994 to 270 $\mu g\,L^{-1}$ in 1998, with a range of 116–796 $\mu g\,L^{-1}$. The percentage of schoolchildren with adequate UIC increased from 10.0% to 77.3%. The 1998 study obtained 894 dietary salt samples from retailers and found that iodine content in 64% of the samples were >25 parts per million (p.p.m.) against 7% before the implementation of the UDSI programme (Attama *et al*. 1999; International Council for Control of Iodine Deficiency Disorders 2002). However, since the significant results of 1998, a slowdown in progress against iodine deficiency was observed in Niger. Thus, in 2001, the ThyroMobil visited selected sites; the median UIC was 54 $\mu g\,L^{-1}$ in sharp contrast to the 1998 data (International Council for Control of Iodine Deficiency Disorders 2002). In 2006, on the 1000 dietary salt samples collected from retailers in the eight regions of Niger, 78.7% presented iodine content below 25 p.p.m. (Wuehler & Biga Hassoumi 2011). In 2010, 32.6% of infants consulted in the Niamey Urban Community primary health centres (PHCs) had UIC below 100 $\mu g\,L^{-1}$ (Seydou 2010). Data from several countries indicated that lack of a well-monitored dietary salt iodisation (SI) programme was accompanied by recurrence of iodine deficiency (Pantea *et al*. 2010). It is therefore urgent to assess the impact of the slowdown in progress against iodine deficiency on people's health at least for vulnerable groups, notably pregnant women. Most especially, this is a period during which the maternal iodine status is critical for fetal development. Indeed, at this stage of life, maternal thyroxin before onset of the fetal thyroid function and maternal inorganic iodine are crucial for the development of the fetal nervous system, and an inadequate or insufficient of iodine input may irreversibly alter psychomotor development (Sack 2003; Delange 2004; Zoeller & Rover 2004).

The aim of our study was to assess the iodine status among pregnant women in a context where national controls are not effective at ensuring universal availability of adequately iodised salt. This is mainly to assess the impact of the slowdown in the fight against iodine deficiency in this vulnerable group.

Materials and methods

The study was carried out in the district PHCs of Gamkalé, Saga and Lamordé located in Niamey, the Niger Republic's capital. Gamkalé is a mixed population district, Lamordé a district of breeders and Saga a district of rice farmers and fishermen. Two hundred forty pregnant women volunteers were recruited at the rate of 80 pregnant women in each district PHC. A control group of 60 healthy non-pregnant, non-lactating women was constituted. The volunteers were recruited in the three districts at the rate of one woman every three families. All women with previous history of thyroid disease or medications that affect thyroid status, including those with systemic illness, were excluded from the study. The distribution of pregnant and control group women according to age, parity and educational level was presented in Table 1.

Key messages

- Iodine deficiency among pregnant women is a public health concern and therefore it is urgent to envisage iodine supplement in these populations.
- A survey should be conducted to see if iodine deficiency in pregnant women is related to the shortcoming of the UDSI programme or to their customary food intake.
- Intensive education and awareness campaigns should be conducted in the population to encourage pregnant women to consume adequate amount of iodised salt.

Table 1. Demographics of pregnant and non-pregnant women according to provenance, age, parity, educational level and gestational age

Parameters	Pregnant women			Control group		
	Gamkalé	Lamordé	Saga (%)	Gamkalé	Lamordé	Saga (%)
Age (years)						
<20	22.50	15.00	20.00	0.00	20.00	0.00
21–25	26.25	31.25	25.00	0.00	40.00	0.00
26–30	31.25	30.00	23.75	30.00	40.00	0.00
>30	20.00	23.75	31.25	70.00	0.00	100
Parity (precedent)						
0	0.00	63.33	0.00	30.00	15.00	20.00
1	32.50	36.67	0.00	10.00	20.00	5.00
2	52.50	0.00	0.00	10.00	5.00	30.00
>2	15.00	0.00	100	50.00	60.00	45.00
Educational level						
Not enrolled	40.00	38.75	57.50	20.00	30.00	15.00
Primary	42.50	31.25	25.00	55.00	15.00	10.00
Secondary high	17.50	30.00	17.50	25.00	55.00	75.00
Gestational age						
First trimester	33.75	28.75	28.75			
Second trimester	32.50	35.00	30.00			
Third trimester	33.75	36.25	41.25			

The protocol was in accordance with the Helsinki Declaration of 1975 revised in 2008. The study was endorsed by the National Ethics Committee and the Academic Scientific Council of Abdou Moumouni University. Participation in the study was voluntary. The aim of the study was explained to the women and consents were obtained. Once enrolled, the women completed a questionnaire that included age, provenance of the woman, gestational age (obtained from the PHC record), parity, educational level and income of the family.

The measurement of UIC was used as a criterion for the assessment of nutritional status in iodine. The participants were asked to provide 5–10 mL casual samples of urine for iodine analysis. Casual urine samples were used for the assessment of UIC (WHO *et al*. 2007). The urine samples were analysed using the method of Wawschinek as modified by Dunn *et al*. (1993).

The statistical analysis was carried out using SPSS 17.0 program (SPSS Inc., Chicago, IL, USA). First, we verified among the pregnant women (240) if a relationship existed between UIC and provenance, age, parity and educational level. Secondly, we analysed the same parameters but, this time, in the global samples (300). The Kolmogorov–Smirnov test indicated that the UICs were not normally distributed; thus, the Mann–Whitney *U*-test was used to check whether there is any relationship between pregnancy and UIC. Now the Kruskal–Wallis test was used to check if there is a relationship between UIC and provenance, age, parity and educational level. $P < 0.05$ was considered significant.

Results

The age range of the 60 women in the control group was 14–45 years, mean age 37.87 ± 6.77 years (mean ± standard deviation). For the 240 pregnant women, the age range was 15–45 years and mean age 27.15 ± 6.56 years. Seventy-three (30.42%) women were in their first trimester of pregnancy, 78 (32.50%) were in their second trimester and 89 (37.08%) were in their third trimester.

The median UIC of the control group was 166 $\mu g\ L^{-1}$, which is within the range of 100–199 $\mu g\ L^{-1}$ defined as optimal (WHO *et al*. 2007), and their 20th percentile UIC value was greater than 50 $\mu g\ L^{-1}$ recommended, indicating an optimal status

Table 2. Urinary iodine concentration (UIC) and percentage below cut-off points for pregnant women in first, second and third trimester, and for the control group

Parameters	All pregnant	First trimester	Second trimester	Third trimester	Control group
N	240	73	78	89	60
Median UIC ($\mu g\ L^{-1}$)	119	144	108	92	166
Minimum	2	8	8	2	22
Maximum	1168	890	1168	890	870
20th percentile ($\mu g\ L^{-1}$)	64	85.6	68.8	56	67.2
UIC < 50 $\mu g\ L^{-1}$	10.42 (25)	13.70 (10)	8.97 (7)	8.99 (8)	10.00 (6)%
UIC < 100 $\mu g\ L^{-1}$	40.00 (96)	26.03 (19)	39.74 (31)	51.69 (46)	28.33 (17)%
UIC < 150 $\mu g\ L^{-1}$	61.67 (148)	52.05 (38)	65.38 (51)	66.29 (59)	45.00 (27)%

Figures in parentheses are the number of women.

of iodine nutrition in this studied population (Table 2).

The median UIC of all pregnant women (119 $\mu g\ L^{-1}$) was below the cut-off point of 150 $\mu g\ L^{-1}$ defined as optimal (WHO *et al.* 2007), and more than 60% were deficient in iodine (Table 2). The median UIC of all pregnant women decreased from 144 $\mu g\ L^{-1}$ in the first trimester to 92 $\mu g\ L^{-1}$ in the third trimester; inversely, during the same period, the percentage of all pregnant women deficient in iodine increased from 52% to 66%. Approximately only 1 in 5 pregnant women had UIC within the range of 150–249 defined as adequate (WHO *et al.* 2007).

Among pregnant women, and in the whole sample, no significant relationship was found between UIC and provenance, age and parity. However, significant relationship was found between iodine status and the gestational age and educational level as well as among pregnant women and in the whole sample. A slight significant relationship was found between iodine status of pregnant and non-pregnant women.

Discussion

According to the World Health Organization (WHO)/UNICEF/International Council for the Control of Iodine Deficiency Disorders (ICCIDD) for children, non-pregnant and non-lactating women, the median UIC must be ≥100 $\mu g\ L^{-1}$ to prevent IDDs (WHO *et al.* 2007). The median UIC (166 $\mu g\ L^{-1}$) of the 60 women volunteers was within the range of optimal iodine status. In this group, no more than 20% of UI values should be below 50 $\mu g\ L^{-1}$ (WHO *et al.* 2007). In the control group, about 10% of women had a UI value below this cut. Thus, both the median and the distribution indicated adequate dietary iodine intake and an optimal status of iodine nutrition.

To ensure normal thyroid physiology in the mother and the fetus, WHO/UNICEF/ICCIDD recommended a median UIC of ≥150 $\mu g\ L^{-1}$ during pregnancy (Andersson *et al.* 2007; WHO *et al.* 2007). The median UIC for all pregnant women (119 $\mu g\ L^{-1}$) was far lower than the recommended minimum UIC, and only 31.4% of the pregnant women had adequate values >150 $\mu g\ L^{-1}$. We have also observed an exacerbation of the iodine deficiency during pregnancy. Indeed, from the first trimester to the third trimester, the median UIC decreased from 144 to 92 $\mu g\ L^{-1}$, and the percentage of pregnant women with adequate UIC values decreased from 47.95% to 33.29%. This exacerbation of iodine deficiency during the third trimester of pregnancy was previously reported even in areas with adequate iodine intake (Wang et al. 2009a). Our results clearly indicated inadequate consumption of dietary iodine by pregnant women in the studied population. These outcomes are consistent with other reported results that showed even in areas with adequate iodine intake, a significant proportion of pregnant women had UIC below the recommended level (Yan *et al.* 2005; Abalovich *et al.* 2007; Ainy *et al.* 2007; Ategbo *et al.* 2008; Marchioni *et al.* 2008). In contrast, countries with long-standing, successful iodised salt programme (China, Iran, Papua New Guinea and Switzerland) had reported an optimal median UI in pregnant women (Yan *et al*. 2005; Zimmermann *et al*. 2005; Guan *et al*. 2006; Temple *et al*. 2006; Azizi 2007; Amoa & Rubiang 2009; Wang *et al*. 2009b).

Niger had adopted the UDSI in 1996. Two years after, in school, the median UI increased from 34 to 270 μg L^{-1}, and the percentage of schoolchildren with normal UI excretion increased from 10% to 77.3% (Attama *et al*. 1999; International Council for Control of Iodine Deficiency Disorders 2002). Since then, various studies strongly suggested a slowdown in progress against iodine deficiency in Niger (Wuehler & Biga Hassoumi 2011). The results of this study clearly confirmed these observations, at least among the pregnant women of the studied population. This should be a serious concern because data from several countries indicated that lack of a well-monitored SI programme was matched with iodine deficiency recurrence (Pantea *et al*. 2010). Iodine is the key element required for the synthesis of thyroid hormones crucial for the development of the fetus especially for the neuronal migration and the myelination of the fetal brain (Morreale de Escobar *et al*. 2004; Zimmermann *et al*. 2008). During the period of brain growth and especially during the first semester of pregnancy, even moderate iodine deficiency can cause irreversible damages (Glinoer 2007; Eastman & Zimmermann 2011). Severe iodine deficiency during pregnancy also increases the risk of abortion, perinatal mortality, premature birth or low birthweight (Pharoah *et al*. 1971; Dillon & Milliez 2000).

Adequacy of iodine content of salts to achieve optimal iodine intake in pregnant women is recommended. This can be achieved by conducting intensive education and awareness campaign in the population for pregnant women to consume adequate amount of iodised salt. It is also necessary to reinvigorate and to regularly evaluate the implementation of the UDSI strategy in Niger. Most especially as the results obtained in areas where the UDSI programme has been successfully conducted showed an improvement of nutritional iodine status of pregnant women with a median UIC within the recommended range (Yan *et al*. 2005; Zimmermann *et al*. 2005; Guan *et al*. 2006; Temple *et al*. 2006; Azizi 2007; Amoa & Rubiang 2009; Wang *et al*. 2009b).

No significant relationship was found between nutritional iodine status and provenance, age and parity among pregnant women and also in the whole sample. These are consistent with previous observations (Pouessel *et al*. 2003; Gowachirapant *et al*. 2009). However, significant relationship was found between iodine status and the gestational age and the school level ($P < 0.05$) among pregnant women and the whole sample. Indeed, the UIC decreased significantly from the first to the third trimester of pregnancy. The significance became much more obvious when we compared the UIC of control group with that of the pregnant women in the third trimester of pregnancy. Also we found out that the UIC increased significantly with the educational level in the control group and that of pregnant women. A slight significant relationship was found between iodine status of pregnant and non-pregnant women ($P = 0.057$).

Conclusion

In pregnant women, iodine deficiency constituted a significant public health problem. The median UIC value is far below the range of optimal iodine status and about 62% have an inadequate iodine status. Our results strongly suggested an urgent need of iodine supplement for pregnant women. A survey on this issue should be carried out with consistent means. It would be also important to know if this higher suboptimal status of iodine nutrition among the pregnant women of the studied population is related to shortcoming of the UDSI programme in Niger or their food intake habit dictated by customary taboo.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

HD and HS designed the research. HS and AS conducted the research. HS and MMA analysed data. HS prepared the manuscript. All authors reviewed the manuscript. HS has primary responsibility for final content.

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