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Nutritional iodine status of students from the Faculty of Health Sciences of Abdou Moumouni University of Niamey / Niger

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Abstract:
Context: *The republic of Niger has adopted the universal dietary salt iodization policy since 1996 in order to combat iodine deficiency disorders. Notwithstanding this, various studies reported that consumption of iodized salt is still suboptimal. Unfortunately, none of these studies concerned the student environment.* ***Objective****: The study was to assess nutritional iodine status among students from AbdouMoumouni University of Niamey.* ***Methods****: It was a cross-sectional study that concerned students from the Faculty of Health Sciences enrolled for the 2020-2021 academic year.The participation to the study was voluntary and an acceptance form was signed by each participant. Urinary iodine concentration (UIC) was used as a criterion for evaluating the nutritional iodine status. The presence of goiter was detected by the palpation of the thyroid gland. A pre-established survey form was used to collect the socio-demographic data of the participants.* ***Results****: Three hundred and seventy-four (374) students, of which 46,3% girls were enlisted. The urinary iodine concentration range from 10 to 1600µg/L, with an average of 150.6 ± 93.4µg/L. The median value is 110µg/L, which is located in the optimal range as defined by WHO. Iodine deficiency (UIC<100µg/L) concerned 43.58% of the workforce. Excess urinary iodine level was observed in 18.18% of the subjects, including 10.96% having a UIC between 200 to 299µg/L and 7.22% having a UIC above 300µg/L. The goiter prevalence was 2.35%, exclusively as type G1 goiter; that is palpable but not visible.* ***Conclusion****: median urinary iodine as well as the proportion of students with a UIC<50µg/L, (13.63%) indicate that the global nutritional iodine status is adequate. However, nutritional iodine deficiency affected 43.58% of students. It is therefore necessary to revitalize the Universal Dietary Salt Iodization (UDSI) program.*

Keywords*: iodine, ioduria, goiter, student, Niger.*

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I. Introduction:

In Niger, the first studies on iodine deficiency disorders (IDD) revealed the prevalence of endemic goiter in certain regions (**1, 2**). In 1994, the first national survey carried out in school children showed that the endemic goiter was of the moderate type. It was associated with a very low iodine intake (**3**). From those findings Universal Dietary Salt Iodization (UDSI) program was adopted in 1996, as a strategy for the prevention, the control and the elimination of iodine deficiency (**4**). In 1998, 2 years after the introduction of iodized salt, a survey assessed 944 scholars from 237 primary schools in the eight regions of the country. The median ioduria has increased from 34 µg/L to 270 µg/L, an 8 fold increase, and the percentage of school children with an ioduria greater than 100 µg/L, corresponding to an adequate iodine intake, has increased from 10 to 77,3%, and an increase of 67,3% between 1994 and 1998, respectively. In the 1998 survey study, 64% of the 894 dietery salt samples collected from retailers have iodine content superior to 25 parts per million (p.p.m.) compared to the 7% before the implementation of the UDSI program (**5, 6**). However, since the significant results of 1998, a slowdown in progress against iodine deficiency has been observed in Niger (**4, 6, 7, 8, 9**). Unfortunately, none of these studies have concerned the student population. Yet in adults and adolescents, even moderate chronic iodine deficiency can lead to mental retardation, apathy, reduced work capacity, cognitive dysfunction and reduced thyroid hormones production (**10, 11**). Futhermore, epidemiological studies conducted in China, Denmark and Turkey strongly suggest that iodized salt supplementation could increase the prevalence of thyroid (**12**) and/or autoimmune (**13**) diseases (**14**).The aim

of the present study was to assess the nutritional iodine status among students from the Faculty of Health Sciences of Abdou Moumouni University in Niamey through urinary iodine concentration.

II. Methods:

This descriptive cross-sectional study was carried out among students from the Faculty of Health Sciences (FSS) of Abdou Moumouni University of Niamey. The students were given insights on the study importance, on the nutritional iodine status and the consequencies of iodine deficieny on their academic and even their general wellfare. The study conditions were also explained, particularly condtions of urine collection and the technic of palpation of the thyroid. Thus, each participant had signed a declaration of his free consent. A pre-established survey form had been used to collect socio-demographic data: age, sex, parents' profession, residence in the campus and attendance at the university restaurant. Are selected for the study, students who have completed the form, submited a valid urine sample and participated to the palpation of the thyroid gland. A total of 374 out of 3.454 students regularly enrolled for the 2020-2021 academic year, i.e. 10.83% of the workforce, have submited valid completed form and urine sample. But only 340 out of these have participated to the goiter test. Each student have collected, in an airtight closed pot of about 30 mL, the morning urine (but not the first urine) which was immediately transported to the FSS' biochemistry laboratory.The aliquot should not be from first morning urine because first morning urine under estimates iodine levels (**15**). Urine samples were stored at -20°C until processing. Urinary iodine concentration (UIC) was used as a criterion for evaluating nutritional iodine status. Urinary iodine level was determined according to the method of (**16**). However, the present method involves digestion with ammonium persulfate. Ammonium persulfate is less dangerous than the chloric acid usually used (**17, 18**). Iodine levels were expressed in µg/L of urine. At submission of urine sample the student passes the test of palpation of the thyroid gland using the two-thumbs technic.The stages of goiter were determined according to the simplified WHO classification (**19**).

III. Data processing

The data were analyzed and processed by the Epi Info 7.2.3.0 software, Atlanta Center for Disease Control and Prevention (CDC), United States in collaboration with the World Health Organization (WHO). The chi square test, at the risk $\alpha = 5\%$, was used to establish factors linked with urinary iodine level and goiter. Chi square hypotheses: **H0**: All proportions are equal; **H1**: At least one proportion different from others. When p-value <5, H0 hypothesis is rejected.

IV. Results:

Three hundred and seventy-four (374) students were enrolled for this study. The sociodemographic characteristics are presented in **Table 1.** The participants were aged from 17 to 37, with an average age of 22.04±2.16years. About 82% of the students were aged between 20 and 24years, with 46% girls and only 21% of the surveyed students living within the city campus. Students with civil servant as household family head constitute majority of the participants, followed by those of merchant parents, 58.6% and 23% respectively. About 54% of the students do not take their meal at the university restaurant and 31% only do take occasionally.

Table 1: Socio-demographic characteristics of students

Socio-demographic characteristics	Frequency %(n)
Age group (year)	
15-19	7,75 (29)
20-24	81,55 (305)
≥ 25	10,70(40)
Total	100 (374)
Gender	
Female	46,3(173)
Male	53,7(201)
Total	100 (374)
Campus residence	
Resident	46,3(173)
Non-resident	53,7(201)
Total	100 (374)
University restaurant attendancy	
Exclusively *	2,41 (9)
Frequently **	11,50 (43)
Occasionnaly ***	31,55 (118)
Never	54,54 (204)
Total	100 (374)

The number in parentheses indicates the number of subjects. ***** All meals in the restaurant. ****** At least one meal a day. ******* Not more than 2 to 3 meals in a week.

Table 2: Distribution of nutritional iodine status

	UIC (µg/L)	Distribution %(N)
Maximum	1600	
Minimum	10	
Mean	150,6±93,4	
Median	110	
20^{e} percentile	65	
Nutritional status		
Severe deficiency	<20	4,01(15)
Moderate deficiency	20 – 49	9,62(36)
Mild deficiency	50 – 99	29,95(112)
Adequate	100 -199	38,24(143)
Risc HII**	200 – 299	10,96(41)
Risc HII**	≥ 300	7,22(27)

The number in parentheses indicates the number of subjects. **UIC**: urinary iodine concentration. HII**: hyperthyroidism iodine-induced

The median ioduria was 110µg/L; it is located in the optimal range defined by the WHO. In addition, the percentage of students, (around 14%), with a UIC <50 µg/L is well below the 20% tolerated in a given population. Nevertheless, only 56% of the students had a UIC above the reference value of 100µg/L, of which about 38% had a UIC in the range 100-199µg/L considered as adequate. About 44% had iodine deficiency, of which 30% with mild deficiency, 10% moderate deficiency, and 4% severe deficiency (**Table 2**). All so, excess iodine level could affect about 18% of students (UIC >200µg/L).

Table 3: Distribution (percentage) of subjects according to goiter stage

Goiter Stage	Clinical signs	%(N)
Stage G0	Goiter not visible, not palpable	97,65 (332)
Stage G1	Goiter not visible, but palpable	2,35 (8)
Stage G2	Goiter palpable and visible	0,00 (0)
Stage G3	Goiter voluminous	0,00 (0)
Total		100 (340)

The number in parentheses indicates the number of subjects.

Table 3 shows the percentage distribution of subjects according to goiter stage. From the 340 students who participated to the thyroid palpation, only 8 present a goiter of stage G1, 2.35%

. **Tableau 4: Distribution (percentage) of nutritional iodine status by sex, age group and profession of student's household head.**

UIC (µg/L)	Nutritional status	Gender		p	Age group (year)			p	Profession of household head				p
		Female	Male		17-19	20-24	≥ 25		Civil S*	Trad**.	Farm**.	Others****	
Median		110	110		115	110	115		111,3	111,3	110	105	
<20	Severe	1,61(6)	2,41(9)		0,00(0)	3,48(13)	0,53(2)		2,67(10)	0,53(2)	0,53(2)	0,27(1)	
20-49	Moderate	4,81(18)	4,81(18)		0,80(3)	6,68(25)	2,14(8)		5,88(22)	1,87(7)	1,34(5)	0,53(2)	
50-99	Mild	13,63(51)	16,31(61)		1,60(6)	26,20(98)	2,14(8)		16,04(60)	8,56(32)	4,55(17)	0,80(3)	
100 -199	Adequate	18,98(71)	19,25(72)	0,61	3,21(12)	31,28(117)	3,74(14)	0,44	23,26(87)	7,23(27)	6,68(25)	1,07(4)	0,85
200 – 299	Risc HII	3,74(14)	7,22(27)		1,34(5)	8,02(30)	1,60(6)		5,88(22)	2,94(11)	1,60(6)	0,53(2)	
≥ 300	Risc HII	3,48(13)	3,74(14)		0,80(3)	5,88(22)	0,53(2)		4,81(18)	1,87(7)	0,27(1)	0,27(1)	
Total		46,27 (173)	53,73(201)		7,75(29)	81,55(305)	10,70(40)		58,56(219)	22,99(86)	14,97(56)	3,48(13)	

The number in parentheses indicates the number of subjects. **Civil S*:** Civil servant. **Trad**:** Trader. **Farm***:** Farmer. **Others****:** All professions non indicated

Table 4 presents the percentage distribution of the nutritional iodine status by gender, age group and profession of the household head of students. The median urinary iodine is 110µg/L within both sexes. It is relatively higher in the age group 17 - 19 years and that the group ≥25 years. It is also relatively higher among students whose household head is a civil servant or a trader.

Iodine deficiencies, as well as excess iodine level are on the other hand relatively higher in the male sex, in the 20-24 age groups and within students with household head as civil servant. However, the differences in urinary iodine concentration in the sexes, age groups and household head profession do not reach the significance threshold (p>0.05).

Table 5 presents the percentage distribution of nutritional iodine status according to the place of residence, the attendance at the university restaurant or the presence of goiter

Table 5: Distribution (percentage) of nutritional iodine status according to campus residence, attendance at the university restaurant or presence of goiter.

UI (µg / L)	Nutritional iodine status	Campus residence		p	Attendence of university restaurant				p	Presence of goiter		p
		Resident	Non-resident		Exclusively	Frequentely	Occasionnally	Never		Stage G0	Stage G1	
Median		110	110		105	111,3	110	110		110	112,5	
<20	Severe	0,53(2)	3,48(13)		0,00(0)	0,00(0)	1,07(4)	2,94(11)		4,01 (15)	0,00(0)	
20-49	Moderate	2,94(11)	6,68(25)		0,00(0)	1,34(5)	2,94(11)	5,35(20)		7,49 (28)	0,80(3)	
50-99	Mild	6,42(24)	23,53(88)		0,80(3)	4,55(17)	8,02(30)	16,58(62)		26,74 (100)	0,54(2)	
100 -199	Adequate	8,02(30)	30,21(113)	0,48	1,34(5)	4,28(16)	12,57(47)	20,05(75)	0,77	34,49 (129)	0,00(0)	0,01
200 – 299	Risc HII	1,34(5)	9,63(36)		0,27(1)	1,07(4)	4,01(15)	5,61(21)		9,63 (36)	0,54(2)	
≥ 300	Risc HII	1,60(6)	5,61(21)		0,00(0)	0,27(1)	2,94(11)	4,01(15)		6,42 (24)	0,28(1)	
Total		20,86(78)	79,14(296)		2,40(9)	11,50(43)	31,55(118)	54,55(204)		97,65 (0)	2,35(8)	

The number in parentheses indicates the number of subjects.

The median of urinary iodine is 110µg/L and homogeneous among both students living and non-living on the University campus. However, the median value is higher among students who eat occasionally at the university restaurant, and among goitrous subjects. The urinary iodine level was found not significantly related to residency or attendancy to the university restaurant, with the respective p-values (p=0.48); (p=0.77). On the other hand, urinary iodine is significantly linked to the presence of goiter (p=0.01).

No student with adequate iodine status, or severe iodine deficiency present goiter. Five students were identified with iodine deficiency (UIC<100µg/L), and three with excess urinary iodine level (UIC>199µg/L) presented goiter.
Table 6 shows the percentage distribution of goiter by sex, age group and profession of student's household head.

Table 6: Distribution (percentage) of goiter by sex, age group and profession of student's household head.

Goiter	Gender		p	Age group (year)			p	Profession of household Head				p
	Female	Male		17-19	20-24	≥ 25		Civil S*	Trad**	Farm***	Others****	
Stage G0	44,71(152)	52,94(180)		7,35(25)	79,41(270)	10,88(37)		57,94(197)	20,88(71)	15,00(51)	3,82(13)	
Stage G1	0,59(2)	1,76(6)		0,00(0)	2,35(8)	0,00(0)		0,88(3)	1,47(5)	0,00(0)	0,00(0)	
Stage G2	0,00(0)	0,00(0)	0,25	0,00(0)	0,00(0)	0,00(0)	0,40	0,00(0)	0,00(0)	0,00(0)	0,00(0)	0,04
Stage G3	0,00(0)	0,00(0)		0,00(0)	0,00(0)	0,00(0)		0,00(0)	0,00(0)	0,00(0)	0,00(0)	
Total	45,30(154)	54,70(186)		7,35(25)	81,76(278)	10,88(37)		58,82(200)	22,35(76)	15,00(51)	3,82(13)	

The number in parentheses indicates the number of subjects. **Civil S***: Civil servant. **Trad****: Trader. **Farm*****: Farmer. **Others******: All professions non indicated

It appears that goiter was more common in males, was only observed in the 20-24years age group and only in students whose household head was a trader or a civil servant. Neither the sex, nor the age was associated with goiter (p=0.25); (p=0.40) respectively. However, there is a significant link between the presence of goiter and the profession of the household head, (p=0.04).

Table 7: Distribution (percentage) of goiter by the residence on the city campus and the attendance to the university restaurant.

Goiter	Residence on the campus		p	Attendance to the university restaurant				p
	Resident	Non-resident		Exclusively	Fréquentely	Occasionnally	Never	
Stage G0	19,71%(67)	77,94%(265)		2,06(7)	12,35(42)	30,59(104)	52,65(179)	
Stage G1	0,59%(2)	1,76%(6)		0,00(0)	0,00(0)	1,18(4)	1,18(4)	
Stage G2	0,00(0)	0,00(0)	0,66	0,00(0)	0,00(0)	0,00(0)	0,00(0)	0,56
Stage G3	0,00(0)	0,00(0)		0,00(0)	0,00(0)	0,00(0)	0,00(0)	
Total	20,30(69)	79,70(271)		2,06(7)	12,35(42)	31,77(108)	53,73(183)	

The number in parentheses indicates the number of subjects.

Table 7 shows that goiter was more common among non-resident, 1.76% versus 0.60%. Students eating exclusively or frequently at the university's restaurant present no goiter. However, goitre was equally distributed among students who take their meal occasionally or never (p=1.18%) at the university restaurant. There is no signifficant link of the residence or university restaurant attendancy with goiter, (p=0.66); (p=0.56), respectively.

V. Discussion:

The two main means of assessing iodine deficiency in a population are urinary iodine excretion and the prevalence of goiter. In the present study, the median UIC (110 µg/L) was above the minimum value of 100µg/L recommended as adequate in a given population to prevent IDD. Moreover, the proportion of subjects (14%) with a UIC<50 µg/L is lower than the 20% tolerated in a given population (**20, 21**). Thus, both the median UIC and the iodine distribution indicated adequate dietary iodine intake and optimal nutritional iodine status (**21**). However, both the median and the proportion of subjects with UIC ≥100µg/L were lower than previously reported. Indeed in 1998, 2 years after adoption of the UDSI in 1996, the median iodine value among scholars had risen from 34 to 270µg/L, and the proportion of scholars with iodine value greater than 100µg/L had increesed from 10% to 77.3% (**5, 6**). Unfortunately, after the successful results of 1998, various studies had reported a slowdown in the progress of the iodine deficiency control in Niger (**7**). In 2012, in Tiguey, a former endemic-goiter village, the observed median UIC was 166µg/L, 68.34% of the population had a UIC >100 µg/L and around 13.50% had UIC <50µg/L**.** (**22**). In non-pregnant, non-breastfeeding women, the median UIC observed was 166 µg/L, 61.17% had a UIC >100µg/L and 10% had UIC <50µg/L (**8**). In the present studies, the median urinary iodine level was 110µg/L, approximately 44% of the subjects had a suboptimal nutritional iodine status (UIC < 100 µg/L), 4% of whom had a severe deficiency (UIC < 20 µg/L).These results clearly confirm the decrease in median UIC and the increase in suboptimal iodine nutritional status.This could be due to suboptimal intake of adequately iodized salt. Indeed, since the year 2002, from 1000 samples of dietary salt collected from retailers in the eight regions of Niger, 78.7% had an iodine content of less than 25 ppm (**23**). In 2012 also, from 250 dietary salt samples collected from markets and 222 samples from households in the capital Niamey, 87.6% and 84.7% had iodine levels < 15ppm, respectively (**4**). Around 18% of the students had ioduria above 200µg/L and may be at risk of hyperthyroidism iodine-induced (HII). In a previous study in Niger, 39.5% of subjects had an UIC >200µg/L among whom 20.38% had a UIC >300 µg/L (**22**). Excess iodine intakes are not exceptional. In a study carried out in Brazil, excess ioduria affected 44.2% of schoolchildren (**24**). In two Korean regions, 63.9% and 76.7% of schoolchildren had excess ioduria.(**25, 26**). It is stated that most individuals can tolerate relatively high iodine intake without any obvious adverse effects (**21, 27, 28**). However, excessive daily iodine intake (more than 1000.0µg per day) can be potentially harmful to susceptible individuals (**14, 29, 30**).

VI. Conclusion:

The median ioduria (110µg/L) as well as the proportion of students with a CUI<50µg/L, (13.63%), indicate an overall adequate iodine nutritional status.However, nutritional iodine deficiency (ioduria <100µg/L) affects 43.58% of students and remains high. In 1998, 2 years after the introduction of iodized salt, the median value of iodide was 270µg/L and only 22.7% of subjects had iodide <100µg/L. It is therefore necessary to revitalize the urinary iodine level <100µg/L program in Niger.

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