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PREVALENCE OF GOITER AND IODINE NUTRITIONAL STATUS IN SCHOOL AGE CHILDREN OF DISTRICT KARAK, KHYBER PAKHTUNKHWA, PAKISTAN

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Abstract

Context. Pakistan is considered severely iodine deficient on the basis of available data. However this data is collected in patches with severe iodine deficiency.

Objectives. The current study was conducted to know the prevalence of goiter and iodine nutrition status in the district Karak.

Design. Thirty clusters approach was adopted for the study.

Subjects and Methods. From each cluster, 40 school age children (20 boys and 20 girls) of age 6-12 years were randomly selected. A total of 1194 children (boys= 600 and girls= 594) were recruited for the study. Goiter was measured using palpation, urinary iodine by wet digestion and salt iodine content was measured using rapid spot testing kit.

Results. Our results show the total goiter rate to be 14.2% (n=169) in the district. The goiter in girls was 15.8% (n=94) whereas in boys the prevalence was 12.5% (n=75). The median urinary concentration in girls was 65.6±63.68µg/L (IQR= 42.2-83.85) whereas in boys it was 56.8±40.98µg/L (IQR= 36.5-85.8). Median urinary iodine concentration was 62.3±53.28µg/L (IQR= 39.9-85.0) in the district. Iodine level ≥15 ppm was found only in 27.5% household salt samples and 72.3% salt samples had <15 ppm iodine..

Conclusions. Our results show that district Karak is mildly iodine deficient with moderate prevalence of goiter. Immediate prophylactic measures should be taken for compulsory use of iodized salt.

Key words: goiter, urinary iodine concentration, iodine, Karak.

INTRODUCTION

Iodine is the essential element for production of thyroid hormones by thyroid gland. It is widely and unequally distributed on the earth. Iodine deficiency leads to a number of disorders collectively called as iodine deficiency disorders (IDDs) (1). Brain damage is the irreversible disorder caused by iodine deficiency (2). The introduction of iodine into surface water and groundwater occurs principally through rainwater for non-coastal land regions and the combination of rain-water and ocean spray in coastal areas (3).

In 1990 World Health Organization (WHO) reported that 50 million people may be affected from iodine deficiency with the prevalence of goiter ranges from 55% in the plain areas to as high as 80-90% in the hilly areas (4). WHO estimates that nearly 2 billion individuals have an insufficient iodine intake including one third of all school-age children. United States of America (USA) has the lowest prevalence of iodine deficiency 10.6% where 90% households consume iodized salt with highest percentage in the world. Europe had the higher prevalence of iodine deficiency (52.4%) reported in the last decades of the 20th century where the household iodized salt consumption was 50.2% which is much lower than the recommended levels. Many countries in Europe still have weak IDD control programs (5).

In 2004, Pakistan was although categorized as a severely iodine deficient country (6), however, National Nutrition Survey (NNS) of Pakistan reported goiter prevalence to be 10.4% prevalence in 2001 in mothers (5.8% in urban and 11.8% in rural). NNS after 10 years in 2011 reported positive progress in reduction of the prevalence of goiter up to 1.8% in urban areas and 3.4% in rural areas (7). However, the results of NNS are not matching the other sub-national studies conducted in recent years.

District Karak is located in the southern part of Khyber Pakhtoonkhwa (KP) province of Pakistan with a total area of 3.372 square kilometers. According to the census report of 1998, the total population of the district was 430.796 persons (8). The district is mountainous

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with broad valleys and interlocking spurs. Karak is an arid district with annual average precipitation of 330 mm that may vary in time and magnitude (9). The current study was designed to figure out the prevalence of goiter and status of iodine deficiency in the district Karak.

There is not enough data about iodine nutrition status in district Karak. Therefore the current study was conducted to investigate the iodine nutrition status. It will be helpful for local administration and will contribute towards mapping of IDD's throughout the country.

MATERIALS AND METHODS

Study design and sampling method

Thirty clusters approach was adopted recommended by International Council for the Control of Iodine Deficiency Disorders (ICCIDD)/ United Nation Children's Fund (UNICEF)/WHO for the current study using random sampling. The survey was conducted with the written consent of district education officer and details of the primary schools of the whole district were also provided by the same office. In each cluster 40 children of primary school (6-12 years) were randomly selected. An equal number of boys (n=20) and girls (n=20) children were sampled for the study. Ultimately a total of 1194 children (boys= 600 and girls= 594) were recruited for the study. A questionnaire containing close end questions was provided to each subject for the purpose to get relevant information about the socio-economic status, iodized salt utilization, and knowledge about IDD, etc. Goiter size was graded (0, I, II) according to the ICCIDD/ /UNICEF/WHO through palpation by a single trained observer. Palpation is an easy and convenient method which also compensates limited resources. Palpation is recommended to be used for measuring baseline severity of iodine deficiency. The current study was conducted by a single trained observer in order to avoid interobservor variation. The observer was trained at district headquarters hospital Karak for one month.

Grade 0: not visible, not palpable;

Grade I: palpable, not visible;

Grade II: palpable and visible;

The sum of goiter grade I and grade II was taken as total goiter rate (2, 10).

Urinary iodine analysis

The iodine content of water is an indicator of the iodine content in soil and in nutrients(11). Iodine intake can be indirectly investigated through urinary iodine concentration. Therefore urine sample was collected from each subject in tight screw capped tubes and transferred to the Institute of Radiotherapy and Nuclear Medicine (IRNUM), Peshawar and was kept at 4°C for urinary iodine analysis. The degrees of iodine deficiency were defined according to ICCIDD / UNICEF/ WHO as follows:

I) Severe iodine deficiency (<20 µg/L).

II) Moderate iodine deficiency (20-49 µg/L) .

III) Mild iodine deficiency (50-99 µg/L).

IV) Optimal (100-199 µg/L).

V) Risk of iodine induced hyperthyroidism within 5-10 years following introduction of iodized salt in susceptible groups (200-299 µg/L).

VI) Risk of adverse health consequences [iodine induced hyperthyroidism, autoimmune thyroid diseases] (>300 µg/L) (12).

To figure out the concentration of iodine in urine, iodine was measured by its catalytic action on the reduction of the ceric ion(Ce^{+4}) to the cerous ion (Ce^{+3}) coupled with the oxidation of As^{+3} to As^{+5}, in the oxido-reduction reaction between ceric ammonium sulfate and arsenious acid. The mentioned reaction, called the Sandell-Kolthoff reaction, is as under:

$$2Ce^{+4} + 2\ I^{-} \rightarrow 2\ Ce^{+3} + I^{2}$$

$$I^{2} + As^{+3} \rightarrow As^{+5} + 2I^{-}$$

The reaction is sluggish, but can be accelerated by the iodide ion. The cerous ion (Ce^{+3}) is colorless, while ceric ion (Ce^{+4}) has a yellow color. Thus, the route of the reaction can be followed by the disappearance of the yellow color as the ceric ion is reduced into cerous ion. The speed of this color disappearance is directly proportional to the amount of iodide catalyzing it and is measured by a spectrophotometer, after an exact time, at 405 nm(13, 14). In order to determine the precision in the assay, interassay coefficient of variance (CV) was calculated which was found to be 5.6%.

Salt iodine analysis

A total of 112 samples of cooking salt were collected from the district and iodine was estimated using rapid spot testing kit. The kit is manufactured by Nutrition division of the National Institute of Health (NIH), Islamabad, Pakistan. The kit tests fortification of salt with potassium iodate. Each sample was tested three times and the consistent results were considered for the study. By putting a drop on salt sample, the colour obtained was compared with the colours on standard scale provided with the Kits (0ppm, 15ppm, 25ppm, 50ppm, and 75ppm) to evaluate the concentration of iodine in the salt.

Data analysis

All the numeric values were put into MS Excel 2007 and analysed age and gender wise for the percentage of different goiter grades, median urinary iodine status, interquartile ranges (IQR) for different age groups and both genders.

RESULTS

Goiter prevalence

In the current study, a total of 1194 children (600 boys and 594 girls) were investigated for goiter prevalence. Our results show that goiter prevalence was found to be15.8% (n=94) in girls whereas in boys it was 12.5% (n=75). Total goiter rate was found to be 14.2% (169). In girls the prevalence of goiter was found to be the highest in 12 years of age 20% (n=3), whereas the lowest goiter rate was observed in 6 years old girls 8.8% (n=7). In boys, the highest goiter rate was observed in 11 years of age 17.6% (n=18), whereas the lowest goiter rate was observed in boys of 10 years of age 9.73% (n=11). Conclusively, girls were more affected with goiter than boys (Table 1).

Urinary iodine levels

A total of 1172 (boys= 588 and girls= 584) urine samples were made available for urinary iodine analysis. Urinary iodine concentration of all the children reflected mild iodine deficiency (50-99 µg/L). Median urinary iodine level of both boys (56.8±40.98µg/L: IQR= 36.5-85.5) and girls (65.6±63.68µg/L; IQR= 42.2-83.85) also reflected mild iodine deficiency in the area. Among the girls the lowest median urinary iodine concentration (UIC) (57±29.67µg/L: IQR= 34.4-79.0) was found in the age of 12 years whereas the highest median UIC (72.3 ±59.49 µg/L: IQR= 46.1-88.35) was estimated in 11 years of age. Among boys the highest median UIC (75±29.41µg/L: IQR= 46.0-85.0) was observed in 12 years of age whereas the lowest median UIC (53.5 ±37.77 µg/L: 29.6-83.5) was recorded in 10 years old age. Overall 10.92% (n=128) children were facing severe iodine deficiency, 25.25% (n=296) had moderate iodine deficiency, 51.10% (n=599) had mild iodine deficiency, 10.40% (n=122) had optimal iodine level and 2.29% (n=27) had iodine level more than the optimal range (Table 2).

Salt iodine status

A total of 112 household salt samples were tested. 72.3% samples had no iodine, 5.35% had 15 ppm, 2.6% had 25 ppm, 3.5% had 50 ppm, and 6.25% had 75ppm whereas 9.8% had more than 75 ppm iodine contents. Results reveal that most of the people were using non-iodized salt (Fig. 1).

Table 1. Goiter prevalence in school age children

Age (Years)	Goiter grade 0		Goiter grade I		Goiter grade II		Total Goiter Rate N (%)
	Boys N (%)	Girls N (%)	Boys N (%)	Girls N (%)	Boys N (%)	Girls N (%)	
6	75 (88.2)	73(91.3)	10(11.8)	7(8.8)	0	0	17(11.0)
7	74(90.2)	79(80.6)	8(9.8)	19(19.4)	0	0	27(15.0)
8	80(84.2)	92(83.6)	15(15.8)	18(16.4)	0	0	33(16.1)
9	78(89.7)	75(84.3)	9(10.3)	14(15.7)	0	0	23(13.1)
10	102(90.3)	97(83.6)	10(8.8)	18(15.5)	1(0.9)	1(0.9)	30(13.1)
11	84(82.4)	72(83.7)	18(17.6)	14(16.3)	0	0	32(17.0)
12	32(88.9)	12(80.0)	4(11.1)	3(20.0)	0	0	7(13.7)
Total	525(87.5)	500(84.2)	74(12.3)	93(15.7)	1(0.2)	1(0.2)	169(14.2)

Table 2. Urinary iodine concentration of school age children

Age (Years)	< 20 µg/L N(%)	20-49 µg/L N(%)	50-99 µg/L N(%)	100-199 µg/L N(%)	200-299 µg/L N(%)	≥300 µg/L N(%)	Median UIC µg/L
6	14(8.64)	48(29.62)	79(48.76)	17(10.43)	3(1.85)	1(0.62)	57
7	19(10.73)	46(25.98)	95(53.67)	12(6.77)	3(1.69)	2(1.12)	62
8	24(11.70)	42(20.48)	117(57.07)	19(9.26)	2(0.97)	1(0.48)	69
9	20(11.42)	41(23.42)	86(49.14)	26(14.85)	1(0.57)	1(0.57)	61
10	24(10.76)	59(26.45)	110(49.32)	23(10.31)	4(1.79)	3(1.34)	58
11	21(11.41)	48(26.08)	88(47.82)	21(11.41)	5(2.71)	1(0.54)	72
12	6(13.04)	12(26.08)	24(52.17)	4(8.69)	0(0)	0(0)	70
Total	128(10.92)	296(25.25)	599(51.10)	122(10.40)	18(1.53)	9(0.76)	62

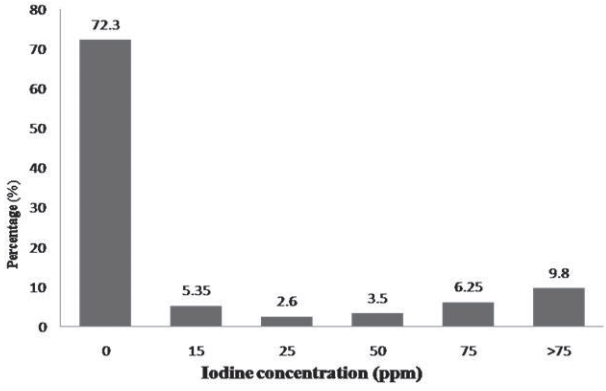

Figure 1. Iodine concentration in the cooking salts sample's of the district.

DISCUSSION

Iodine deficiency leads to many disorders collectively called iodine deficiency disorders (IDDs) including hypothyroidism, mental retardation, irreversible brain damage, cretinism with deaf mutism, reduces somatic growth and cognitive motor function (15-17). School age children are mostly limited to the area and use the nutrients and water of the native area. Children are the true representative of iodine nutrition of community as they can show the exact biochemical picture of community (2).

Goiter prevalence in Pakistan varies region to region based on altitude and topology of the earth. In Abbotabad, one of the northern district total goiter rate is reported to be 23.9% (males 23.1% and females 24.7%) with 58.8% families using iodized salt (18). In Peshawar, the provincial capital city of Khyber Pakhtunkhwa, overall goiter rate was recorded 22% in school age children (5-13 years) in 2000 with 80% population consuming iodized salt (19). In 2001, goiter prevalence recorded in Gilgit was 10.2% and in Skardu it was 40% (20). In district Swat, goiter prevalence was reported to be 52% in boys and 45% in girls in 2003 showing an alarming situation (21). However, another study in the same year reported goiter prevalence to be 4% with 95% population using iodized salt (22). A study conducted in a fraction of district Karak showed a total goiter rate to be 47.55% (49.77% in males and 40.58% in females). Median urinary iodine concentration was 137µg/L in the population (23). A recent study in district Charsadda showed 10.9% prevalence of goiter and median urinary iodine concentration to be 89.9µg/L in school children (24). The total goiter rate of 14.15% in the current study reflects betterment in the situation regarding iodine deficiency. However, complex geographic variations and climatic differences are the major contributing factors in the varying range of the results.

Median UIC also varies in different sub-national studies. A study conducted in 1999 in district Abbottabad showed higher values than ours (18). Another published study of our group in 2014 in district Charsadda also shows higher UIC than the current study (24). Even in the fraction of the current study area higher UIC were recorded (23).

The current study revealed that majority of the households consumed non-iodized salt produced in local salt industry. They were unaware about iodine and its importance for health. However, few were using iodized salt and were aware of its importance. In the rest of the studies performed at district Swat, Peshawar and Abbotabad, (18, 19, 21) salt iodization status was much better compared to the current study. So it is strongly recommended to launch the projects for salt fortification with iodine in the district, as iodine deficiency consequences are severe in the region.

According to National Nutrition Survey (NNS) 2011, across the Pakistan, utilization of iodized salt is reported to be 39.8%. Furthermore, concentration of urinary iodine in different provinces and regions of the world are given in Table 3 (7). Further efforts and attempts are needed to dilute the problem of iodine deficiency. Few studies are found about thyroid excess (25-29), however, with biased methodology, low standardization and lack of uniformity in following the reference ranges. These studies described only prevalence of the thyroid dysfunction (hyperthyroidism). Iodine deficiency in pregnant women play a vital role in thyroid hormones production by the fetal thyroid as less iodine is available

Table 3. Region wise median urinary iodine concentration in 6-12 years children in Pakistan (Adapted from National Nutrition Survey 2011)

	Total	Residence		Province/Region						
		Urban	Rural	Punjab	Sindh	KPK	Balochistan	FATA	AJK	Gilgit
Severely <20 µg/L	2.2	3.4	1.6	2.1	2.1	1	5.5	0	6.5	18.2
Moderate 20-49 µg/L	10.1	7.4	11.4	11.8	7.2	5.8	7.3	0	30.5	20.3
Mild 50-99 µg/L	24.4	27.4	22.9	25.3	25.6	18.9	21.9	10.3	28.5	31.3
Non-Deficient ≥100µg/L	63.3	61.8	64.1	60.7	65	74.2	65.3	89.7	34.6	30.1
N	1222	524	698	585	307	162	61	13	65	29

to the fetal thyroid. Few studies have recently reported iodine deficiency in pregnant women in India and the United Kingdom which ultimately lead to Congenital hypothyroidism (CH) (17,30). In Pakistan few studies are conducted at small scale to find the incidence of CH, however, any program at national level is missing. One of such studies conducted in Faisalabad indicates higher incidence of 1:1000 (31). Another study carried out in Lahore in 2003 shows ≈ 2% CH rate in newborns (32) whereas a recent study conducted at the same city indicates 0.8% CH rate in newborns (33). One of the most systemic studies conducted at Aga Khan Medical University Karachi regarding congenital hypothyroidism from 1989 to 2008 shows very uncertain results as they mention that they have many missing links in their data, but concluded 1:1600 ratio of CH in newborns (34). It is recommended around the world to set reference ranges for local population because of the heterogeneity in TSH level. Voelzke *et al.* (35-36) reported that TSH level may be affected by many factors, for example current iodine supply to the region and history of iodine supply to the region.

District Karak is declared as endemic to goiter and mildly iodine deficient. Poor health conditions and lack of appropriate policies contribute much in intensifying the issue. Therefore, immediate and instant attentions should be paid by local administration and government to address the problem. Salt industries should be directed to avail quality iodized salt.

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Conflict of interest

The authors have no conflict of interest for this article.

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