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ORIGINAL ARTICLE

Goiter Prevalence and Interrelated Components from Coastal Karnataka

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Abstract

Objective To assess prevalence of goiter and associated factors among school going children in Udupi district.

Methods A school based cross-sectional survey was conducted among 6–12 year old children. A sample of 30 villages was selected from the entire district by probability proportionate to size. One school was then randomly selected from each of the 30 villages. Goiter was assessed clinically and was graded as per the recommended criteria of World Health Organization (WHO)/ United Nations Children's Fund (UNICEF)/ International Council for the Control of Iodine Deficiency Disorders (ICCIDD). Salt and urine samples were collected from a subsample for iodine estimation.

Results A total of 2703 children were examined. The mean (±SD) age of the participants was 9.6 y (±1.9). The overall prevalence of goiter in Udupi district was found to be 9.3% with 7.0% and 2.3% having grade 1 and grade 2 goiter respectively. Prevalence of goiter was significantly higher among females [153(11.1%)] as compared to males [98(7.4%)] ($p = 0.001$). Of the 543 salt samples analyzed, 379 (69.8%) salt samples had adequate salt iodine content (> 15 ppm); while among the children with goiter 32 (8.4%) had inadequate salt iodine. Median iodine value was 202.12 mcg/l among the 270 urine samples tested for iodine levels.

Conclusion Goiter prevalence at 9.3% in the coastal district contributes to the endemicity of the public health problem. The district had adequate iodine nutrition based on median urinary iodine levels. Hence, other contributing factors for the persistence of endemic goiter need to be explored.

Keywords Goiter · School children · Iodine deficiency · Prevalence · Urinary iodine

Introduction

Iodine is an important micronutrient required for structural development and optimal functional activity of the thyroid gland and central nervous system. Iodine deficiency is one of the most prevalent micronutrient deficiencies globally and is the main cause of potentially preventable cognitive disability in childhood [1]. Iodine deficiency disorders (IDD) include a spectrum of conditions ranging from endemic goiter, hypothyroidism, cretinism, decreased fertility rate, increased infant mortality, to mental retardation [2].

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It is estimated that 1.5 billion people in the world are at risk of developing Iodine deficiency disorders [3]. Nearly 266 million school-aged children worldwide have insufficient iodine intake. Compared to children living in Iodine sufficient areas, the children living in Iodine deficient areas have a lesser Intelligence Quotient (IQ) by 13.5 points [4]. In India, out of 390 districts surveyed in all 29 states and 7 union territories, 333 districts were found to have the prevalence of the goiter more than 5% which is reported to be endemic for IDD [5]. It is estimated that 54 million people are suffering from goiter in India [6].

It is a well-established fact that except for certain types of goiter, Iodine deficiency disorders are permanent and incurable [3]. But, these disorders could be easily prevented. The simplest, inexpensive and most effective method to prevent the broad spectrum of IDD is to consume iodated salt daily. In view of addressing this problem Government of India launched the National Goiter Control Program in 1962 which was renamed as National Iodine Deficiency Disorders Control Program (NIDDCP). The monitoring of the Iodine deficiency disorders is being done in the nation under NIDDCP by estimating the prevalence of goiter among school children and estimation of urinary iodine for assessing the Iodine nourishment status [3]. Prevalence of goiter >5% and median urinary iodine <100 μg/L is considered to be a public health problem [3]. Even though, the magnitude of IDD has declined in recent years after the introduction of iodized salt, the problem continues, and is not limited to the Sub Himalayan regions as it was thought earlier [7]. Even though Government of India adopted universal iodization program and made it mandatory in the year 2005, nearly 22% of the households in the country end up consuming salt with inadequate iodine [8]. This could be due to various reasons like inaccessibility, faulty storage and usage practices [9]. With this background in mind, the present study was undertaken as part of the state directive for evaluation of the goiter status and associated factors among school children in Udupi district.

Material and Methods

A school based cross-sectional survey was conducted during January 2017 in Udupi district, Karnataka. The study was conducted as per the directives of National Iodine Deficiency Disorders Control Programme (NIDDCP), State Nutrition Cell, Health and Family Welfare Department, Government of Karnataka [3].

Figure 1 depicts the enrollment process and study methodology. The list of all the villages of Udupi district including data pertaining to 2011 population census was obtained from the District Health Office. As per the methodology suggested by NIDDCP, a sample of 30 villages was selected using probability proportionate to size from the three taluks within the district. A village was excluded from the study if the total number of children in all the schools of that village had a class strength <90 children. Random selection of one school was done from each of the 30 villages. A school with strength <30 students was also excluded from the sampling frame. The government directive indicates that house-to-house survey also needs to be done in addition to school surveys if the proportion of out of school children is high. But, in the present study setting, the non-enrollment and dropout rate in the villages was found to be 0.5%. Hence house-to-house survey to identify school dropouts was not deemed essential. A total of 2703 children were recruited for the study. Students in classes 1st to 7th standard from the selected schools were eligible to be enrolled in the study. The survey objectives, design, methods, sample size were all predetermined by the concerned authority [National Iodine Deficiency Disorders Control Programme (NIDDCP), Ministry of Health and Family Welfare, Karnataka] and hence similarity to previous published literature, with respect to the methodology employed is probable. The present institution was selected to conduct the survey as per their directives and hence sample size was not formally calculated and as per the protocol, 2700 children were to be surveyed.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Institutional Ethical clearance was obtained from the Ethics Committee (IEC) of Kasturba Medical College, Manipal (IEC: 922/2016) and due permission from the Deputy Director of Public Instruction (DDPI), Udupi District was also obtained prior to the study. The study was registered prospectively with Clinical Trials Registry of India (CTRI/2017/02/013386). The school Principals of the selected schools were contacted and informed about the survey and their consent was obtained.

Two visits were made to each selected school, after an initial telephonic conversation and confirmation with the concerned school authorities. On the first visit, respective Principals of the selected schools, were approached and briefed about the study. Minimum of 90 students per school were required for the survey. Hence, the list of the school children between 1st and 7th standard was obtained from the school register. From each class around 12–14 students were randomly selected, ensuring an equal male female distribution in each class. The study team comprising of trained post graduates and medical-social workers, briefed the identified children about the study. Subject information

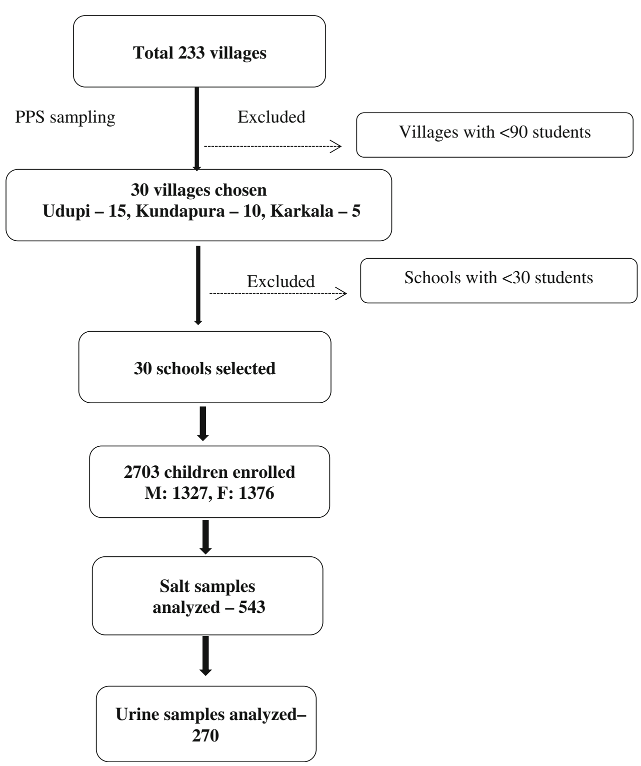

Fig. 1 Study enrollment process

sheets, consent forms and the proforma were handed over to the selected children to be taken home, share the information with the parents and if willing for their child's participation in the study, obtain informed consent from parents and bring back the filled proforma and the signed consent forms the next day. Since the study involved data collection from children, assent from children and written informed consent was obtained from parents.

On the second school visit, all the selected students who had obtained written informed consent from parents were subjected to clinical examination of thyroid gland and goiter grading was done by trained post graduates from Department of Community Medicine as per the recommended criteria of WHO/UNICEF/ICCIDD [3]. One of the postgraduates had additional training and experience in goiter evaluation. In order to address inter-observer variation, any discrepancy or variation or doubtful cases were re-evaluated by him before the final diagnosis of Grade 1 goiter was made.

Grade 0: No palpable or visible goiter
Grade 1: Mass in the neck consistent with enlarged thyroid, palpable but not visible.
Grade 2: Palpable and visible swelling, with the neck in normal position, consistent with enlarged thyroid

As per the IDD survey protocol, 20 students were selected and provided air tight plastic containers on Day 1. Goiter grading did not form a basis for selection of students for assessment of salt samples. They were requested to get approximately two tablespoons of salt used regularly for cooking at home, for iodine testing. Iodine content of the salt was estimated using iodometric titration. Iodine concentration of salt <15 ppm was considered as inadequate and > 15 ppm as adequate based on WHO guidelines [3].

On the second school visit; from the 20 children who provided salt samples, every alternate child was selected to provide 5 ml of urine sample in an air tight plastic container for urinary iodine testing. To reiterate, goiter grading did not form a basis for selection of students for assessment of urine samples, either. It was transported with proper cold chain facilities to the Central Biochemistry Lab, attached to the Medical College and urinary iodine estimation was done using Sandell-Kolthoff method. Median urinary iodine concentration was recorded as deficient (<99 mcg/dl), adequate (100–199 mcg/dl), above requirement (>200 mcg/dl) as per WHO guidelines [3].

Data was entered and analysed using Statistical Package for Social Sciences (SPSS) version 15. The results were summarized as percentages and proportions. Chi-square test was used for univariate analysis. A p-value of <0.05 was considered to be statistically significant.

Results

A total of 2703 children were examined in the survey. As depicted in Table 1, the mean (±SD) age of the participants was 9.6 y (±1.9). The male to female distribution was equal, 1327(49.1%) and 1376(50.9%) respectively. Majority of them 2204(81.5%) were Hindus and more than half were from nuclear families 1361 (53.3%). Nearly one-third of the parents had completed primary education and 1115(43.1%) fathers were working as skilled workers whereas two-thirds 1668 (66.2%) of the mothers were homemakers. It was observed

Table 1 Socio-demographic characteristics of study population

Variables	Category	Number	Percentage
Age in years ($n = 2703$)	6–7	492	18.2
	8–9	722	26.7
	10–11	844	31.2
	12	645	23.9
Gender ($n = 2703$)	Male	1327	49.1
	Female	1376	50.9
Religion ($n = 2703$)	Hindu	2204	81.5
	Muslim	396	14.7
	Christian	92	3.4
	Others	11	0.4
Type of family ($n = 2553$)	Nuclear	1361	53.3
	Joint	1053	41.2
	Three generation	139	5.4
Education of father ($n = 2572$)	Illiterate	67	2.6
	Primary	930	36.2
	High school	863	33.6
	Higher secondary & Above	712	27.7
Education of mother ($n = 2594$)	Illiterate	81	3.1
	Primary	922	35.5
	High school	869	33.5
	Higher secondary & Above	722	27.8
Father's occupation ($n = 2533$)	White collar	417	16.5
	Skilled	1115	41.3
	Unskilled	990	39.1
	Others	11	0.4
Mother's occupation ($n = 2519$)	Home maker	1668	66.2
	Working	851	33.8
Socioeconomic status ($n = 2597$)	APL	909	35.0
	BPL	1688	65.0

APL Above poverty line; *BPL* Below poverty line that 1688(65%) of study population belonged to below poverty line (BPL) category, as per the ration card they possessed.

The overall prevalence of goiter in Udupi district was found to be 9.3% with 7.0% and 2.3% having Grade 1 and Grade 2 goitre respectively. Table 2 illustrates the gender wise prevalence of goiter, salt iodine and urinary iodine levels in the study population. Prevalence of goiter was significantly high among females 153(11.1%) when compared to that of males 98(7.4%) ($\chi2 = 11.18$, $p = 0.001$) and it was significantly more in the age group of 10–12 y [160(10.7%)] when compared to 6–9 y [91(7.5%)] ($\chi2 = 8.38$, $p = 0.004$).

A total of 543 salt samples were collected from the students and analyzed for iodine content. Of the salt samples analyzed 164 (30.2%) samples had iodine content less than the recommended (< 15 ppm) and 379 (69.8%) salt samples had adequate amount of salt iodine content (> 15 ppm). Among the 251 children with goiter, 46 (18.3%) had their salt iodine analysis done of which 14 (30.4%) had inadequate salt iodine. Urinary iodine estimation was done for 270 urine samples and median value was 202.1 mcg/L. Only 11 (4%) had median urinary iodine <100 mcg/dl indicating iodine deficiency but none of them had clinically visible/palpable goiter. Median urinary iodine among children with and without goiter was 193.4 mcg/L and 202.6 mcg/L respectively.

It was observed that nearly two-thirds [1645(61.3%)] of study population was using powdered salt for cooking whereas 570(21.2%) were using crystalline salt and 469(17.5%) were using both. Majority of them were using plastic containers 2403(89.7%) with a closed lid [2593(97.7%)] for storing salt. Only 406(15.1%) of the study population reported exposure of salt to heat and 167(6.3%) reported salt exposure to sunlight. Two-thirds 1843(68.7%) of study population were adding salt half way through while cooking whereas only 191(7.1%) were adding salt towards the end of cooking. Table 3 illustrates distribution of salt storage and usage practices among study population based on presence or absence of goiter.

Table 3 Salt storage and usage practices among the coastal population

Variables	Category	Goitre	
		Present n (%)	Absent n (%)
Type of salt used for cooking ($n = 2684$)	Crystalline	61 (10.7)	509 (89.3)
	Powdered	137 (8.3)	1508 (91.7)
	Both	51 (10.9)	418 (89.1)
Type of container used to store salt ($n = 2679$)	Plastic	215 (8.9)	2188 (91.1)
	Others	35 (12.7)	241 (87.3)
Lid of the container ($n = 2677$)	Closed	243 (9.4)	2350 (90.6)
	Opened	5 (6.0)	79 (94.0)
Salt exposed to heat ($n = 2685$)	Yes	34 (8.4)	372 (91.6)
	No	216 (9.5)	2063 (90.5)
Salt exposed to sunlight ($n = 2632$)	Yes	16 (9.6)	151 (90.4)
	No	231 (9.4)	2234 (90.6)
Time of addition of salt during cooking ($n = 2681$)	Beginning	57 (8.8)	590 (91.2)
	Half way	180 (9.8)	1663 (90.2)
	End	13 (6.8)	178 (93.2)

Discussion

Iodine deficiency has its influence right from development of the fetus and extends to all age groups. Since ages, IDD has been and still continues to be a public health problem in India [3]. NIDDCP was launched to address the problem and as part of the program, district surveys are being carried out to assess the burden of IDD and monitor the program [3]. Total goiter rate serves as an indicator for assessing iodine deficiency in a community as it is the most common manifestation of iodine deficiency [10]. Children with goitre need follow-up with thyroid function tests and anthropometry. Clinical hypothyroidism makes the presence of even grade 1 goitre more relevant, as early identification and appropriate management could prevent long term sequelae. Prevalence of goiter in the present study was found to be 9.3% and the district is labelled to be endemic as the prevalence is greater than 5%. This higher prevalence of goiter might be due to the other possible causes of goiter like deficiency of other micronutrients like iron,

Table 2 Gender wise prevalence of goiter, salt iodine and urinary iodine levels in the study population

Variables	Category	Goitre		p value (Chi-square test)
		Present ($n = 251$) n (%)	Absent ($n = 2452$) n (%)	
Gender ($n = 2703$)	Male	98 (7.4)	1229 (92.6)	**0.001**
	Female	153 (11.1)	1223 (88.9)	
Salt iodine ($n = 543$)	Inadequate (<15 ppm)	14 (8.7)	150 (91.5)	0.971
	Adequate (>15 ppm)	32 (8.4)	347 (91.6)	
Urinary iodine ($n = 270$)	Deficient (<99 mcg/dl)	0 (0.0)	11 (100)	0.337
	Adequate (100–199 mcg/dl)	15 (12.5)	105 (87.5)	
	Above requirement (>200 mcg/dl)	11 (7.9)	128 (92.1)	

selenium, vitamin A [11]. Various studies have reported the prevalence of goiter from 0.12 to 35.9% during the period between 2013 to 2016 [12–21].

Goitre prevalence, in the present study was more in the age group of 10–12 y (10.7%) when compared to 6–9 y (7.5%) and the results are consistent with the study done by Gupta RK et al. in Jammu and Kashmir, where the prevalence among 6–9 y and 10–12 y was 13 and 15% respectively [19]. Higher prevalence among the older children might be due to the fact that thyroid swelling could be more visible and palpable in older children as thyroid size is correlated with body surface area and increases with age [22]. The effect of pubertal changes could also lead to higher goiter prevalence among older children (10–12 y), but the onset of puberty and pubertal changes were not assessed in the present study. Prevalence of goiter in females was found to be significantly higher in comparison to males (11.4 and 7.4% respectively; $p < 0.001$) but these results are in contrast with the study done by Khan MS et al. in Kulgam district in which boys had significantly higher prevalence than girls (21.2 and 16.7% respectively; $p = 0.003$) [23]. Higher prevalence in the 10–12 y olds, especially girls could be attributed to autoimmune thyroiditis which is much more prevalent in this age, but specific assessment for anti-thyroid antibodies was not done in the present study.

Median urinary iodine is regarded as an acceptable and cost-efficient indicator for iodine status of population [24]. Median urinary iodine in the present study was found to be 202.12 μ/L which indicates that there was no deficiency of iodine in the study population and was also considerably higher compared to the study results of Kamath et al. conducted in the same district [20]. In the present study 69.8% of salt samples analyzed had adequate iodine content which was lesser when compared to the studies done by Gupta et al. [19] and Kamath et al. [20] where the proportion of salt samples with adequate iodine were 100 and 76.1% respectively. Although salt iodization was lesser in the present study, goiter prevalence has been halved in comparison to a previous survey [20] in the same geographical area. The probable reasons could be greater awareness regarding correct salt storage and usage practices in the community and operationalization of programs like weekly iron and folic acid supplementation in schools to address micronutrient deficiencies, along with regular deworming at six monthly intervals of all school children. As the exact reasons for these observations are difficult to establish in a cross-sectional design, these postulated hypotheses need further analytical evaluation.

Nearly two-thirds of the households were using powdered salt which is similar to the study done by Bhat et al. where 74.4% of the households surveyed were using powdered salt [25]. In the present study, 379(69.8%) households were using salt with adequate iodine (>15 ppm) which is comparable to the study results of Sen et al. [9]. Salt storage practices in the current study were good, wherein 97.7% were storing salt in closed containers which is better than the results reported by Sharma et al. [26]. In a study done by Kamath et al. [27] in the year 2005, 56% of households reported that salt was being exposed to heat which is much higher when compared to the present study (15.1%) and this reduction may be due to the increase in awareness about the salt storage practices. In the present study, it was observed that most of the households (89.7%) were storing the salt in plastic containers which can be regarded as good storage practice as the loss of iodine is least in plastic containers as found in the study done by Singh et al. [28].

Similar surveys conducted in the present district have shown a declining trend with prevalence of 30% in 2002, [27] 19.5% in 2014 [20] and 9.3% in the present study. In addition, there has also been an improvement in adequacy of salt iodine and urinary iodine levels over the decade.

The data collection primarily was done in schools and direct interviews with household members could not be done. Detailed dietary history, including the use of goitrogens; which could have affected the occurrence of goiter could not be quantified. A detailed evaluation of the subset of children having goiter, including the family members could prove beneficial, in further addressing the determinants of iodine deficiency.

Conclusions

A significant decrease in goiter prevalence can be attributed to the implementation of the program on universal iodization of salt for two decades now and continuous monitoring and evaluation, in addition to the elaborate Information Education Communication (IEC) campaigns. However, the problem of endemic goiter still persists despite adequate urinary iodine levels. Hence, focus of future research needs to shift towards other hitherto unexplored environmental and genetic factors for iodine deficiency. In addition, strengthening of awareness campaigns for improving household storage and usage practices could further improve retention of iodine in the salt.

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Contributions AS, CRR, AK planned and supervised the study. VSP, SKRT collected the data, reviewed the literature and prepared the draft manuscript. AS provided critical inputs into the final version of manuscript. CRR, AK, VSP, SKRT analyzed the data and critically revised the manuscript for important intellectual content. AS will act as guarantor of study.

Compliance with Ethical Standards

Ethical Approval "All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards." Institutional Ethical clearance was obtained from Ethics Committee (IEC) of Kasturba Medical College, Manipal (IEC: 922/2016). Informed consent was obtained from all individual participants included in the study.

Conflict of Interest None.

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References

1. World Health Organization. Effect and safety of salt iodization to prevent iodine deficiency disorders: a systematic review with meta-analyses. [Internet] 2014. Available at: http://apps.who.int/iris/bitstream/10665/148175/1/9789241508285_eng.pdf. Accessed 24 May 2017.
2. World Health Organization. Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers. – 3rd ed [Internet]. Available at: http://apps.who.int/iris/bitstream/10665/43781/1/9789241595827_eng.pdf. Accessed 24 May 2017.
3. National Rural Health Mission IDD & Nutrition Cell Revised Policy Guidelines on National Iodine Deficiency Disorders Control Programme 2006. [Internet]. Available at: http://nrhm.gov.in/images/pdf/programmes/ndcp/niddcp/revised_guidelines.pdf. Accessed 24 May 2017.
4. Pandav CS, Yadav K, Srivastava R, Pandav R, Karmarkar MG. Iodine deficiency disorders (IDD) control in India. Indian J Med Res. 2013;138:418–33.
5. Government of India. Ministry of Health & Family Welfare. National Iodine Deficiency Disorders Control Programme. Available at: http://dghs.gov.in/WriteReadData/userfiles/file/Annexure_IDD_I.pdf. Accessed 19 June 2017.
6. Kalra S, Unnikrishnan AG, Sahay R. The global burden of thyroid disease. Thyroid Res Pract. 2013;10:89–90.
7. Indian National Science Academy. Micro-nutrient security for India– Priorities for research and action. [Internet] 2011. Available at: http://insaindia.res.in/pdf/Micronutrient-Complete.pdf. Accessed 19 Jun 2017.
8. Knowles JM, Garrett GS, Gorstein J, et al. Household coverage with adequately iodized salt varies greatly between countries and by residence type and socioeconomic status within countries: results from 10 national coverage surveys. J Nutr. 2017;147:1004S–14S.
9. Sen TK, Das DK, Biswas AB, Chakrabarty I, Mukhopadhyay S, Roy R. Limited access to iodized salt among the poor and disadvantaged in north 24 Parganas district of West Bengal, India. J Health Popul Nutr. 2010;28:369–74.
10. World Health Organisation. Goitre as a determinant of prevalence and severity of Iodine deficiency disorders in populations [online] 2014. Available at: http://apps.who.int/iris/bitstream/10665/133706/1/WHO_NMH_NHD_EPG_14.5_eng.pdf. Accessed 28 June 2017.
11. Kliegman R, Stanton B, St. Geme JW, Schor NF, Behrman RE. Nelson Textbook of Pediatrics, 20th ed. PA: Elsevier; 2016.
12. Sridhar PV, Kamala CS. Iodine status and prevalence of goitre in school going children in rural area. J Clin Diagn Res. 2014;8: PC15–7.
13. Sinha AK, Sharma H, Panda PS, Chandrakar A, Pradhan SK, Dixit S. Prevalence of goitre, iodine uptake and salt iodization level in Mahasamund district of Chhattisgarh: a baseline study in Central India. Int J Res Med Sci. 2016;4:3590–4.
14. Biradar MK, Manjunath M, Harish BR, Goud BN. Prevalence of iodine deficiency disorders among 6 to 12 years school children of Ramanagara district, Karnataka, India. Int J Community Med Public Health. 2016;3:166–9.
15. Chaudhary C, Pathak R, Ahluwalia SK, Goel RK, Devgan S. Iodine deficiency disorder in children aged 6–12 years of Ambala. Haryana Indian Pediatr. 2013;50:587–9.
16. Sareen N, Kapil U, Nambiar V, Pandey RM, Khenduja P. Iodine nutritional status in Uttarakhand state, India. Indian J Endocrinol Metab. 2016;20:171.
17. Gupta VP, Bharat PP, Kamboj A, Paul B, Mohapatra SC. Prevalence of goitre among primary school children in the Mewat area of Haryana. J Community Health Manag. 2016;3:67–9.
18. Sinha AK, Soni GP, Khes SP, Verma AR. A study of prevalence of iodine deficiency disorders among 6-12 years children of Rajnandgaon District of Chhattisgarh. Int J Health Sci Res. 2016;6:25–31.
19. Gupta RK, Langer B, Raina SK, Kumari R, Jan R, Rani R. Goiter prevalence in school-going children: a cross-sectional study in two border districts of sub-Himalayan Jammu and Kashmir. J Family Med Prim Care. 2016;5:825–8.
20. Kamath V, Jacob G, Agrawal A, Kamath A, Shenoy R. Prevalence of goitre and its associated factors in a coastal district of Karnataka. Indian J Community Health. [Internet]. 31 Dec 2015. Available at: http://www.iapsmupuk.org/journal/index.php/IJCH/article/view/626. Accessed 12 July 2018.
21. Chandra AK, Debnath A, Tripathy S, et al. Environmental factors other than iodine deficiency in the pathogenesis of endemic goiter in the basin of river ganga and bay of Bengal, India. BLDE Univ J Health Sci. 2016;1:33–8.
22. Mesele M, Degu G, Gebrehiwot H. Prevalence and associated factors of goiter among rural children aged 6-12 years old in Northwest Ethiopia, cross-sectional study. BMC Public Health. 2014;14:130.
23. Khan SMS, Mahjabeen R, Masoodi MA, Kauser J, Nabi S. Prevalence of goiter among primary school children of Kulgam District, Jammu & Kashmir, India. Acad Med J India. 2014;2:18–21.
24. World Health Organization. Urinary iodine concentrations for determining iodine status in populations [online] 2013. Available at: http://apps.who.int/iris/bitstream/10665/85972/1/WHO_NMH_NHD_EPG_13.1_eng.pdf. Accessed 28 June 2017.
25. Bhat IA, Pandit IM, Mudassar S. Study on prevalence of iodine deficiency disorder and salt consumption patterns in Jammu region. Indian J Community Med. 2008;33:11–4.
26. Sharma LK, Hossen S. Knowledge, attitude and practices of households on iodized salt at urban slums in Dhaka City [online]. 2016. Available at: http://himachalcampus.pibm.in/research-journals/research-paper-4.html. Accessed 28 June 2017.
27. Kamath R, Bhat V, Rao RS, Das A, KS G, Kamath A. Prevalence of goiter in rural area of Belgaum district, Karnataka. Indian J Community Med. 2009;34:48–51.
28. Singh R, Raghuvanshi RS. Effect of household storage practices on iodine content of iodized salt. Asian J Home Sci. 2014;9:481–3.