Original Article

Iodine deficiency disorders in the Maldives: A public health problem

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Because the Maldives is a country of islands it has been assumed, until now, that iodine deficiency disorders (IDD) are not a public health problem. However, no systematic scientific survey has been carried out to assess the status of IDD in the Maldives. This study represents the first IDD survey by the Government of the Republic of Maldives in association with UNICEF Maldives. Undertaken during June and July 1995, the survey adopted the EPI 30 Cluster sampling technique, as recommended by the Joint WHO/UNICEF/ICCIDD Consultation. Based on population proportion to size, a total of 30 clusters were chosen from sampling frames of all 200 islands. A total of 30 schools and 2834 children aged 6–12 years were surveyed. The total goitre rate was 23.6%, with grade 1 goitre contributing 22.5% of this figure. The prevalence of goitre was greater in girls (26.6%) than in boys (20.7%). The median urinary iodine level was 6.7 µg/dL and 65.5% of children had urinary iodine levels below 10 µg/dL. It is evident from this survey that IDD is a public health problem in the Maldives. Hence, efforts to control IDD should be instituted. The most common method of iodine supplementation is iodised salt. As tested in a non-representative sample of 39 salt samples, only 8% of salt had adequate iodine levels of approximately 15 p.p.m. Because all the atolls are affected there is a need to introduce universal salt iodization in the country.

Key words: Maldives, iodine deficiency disorders (IDD), public health, water, islands, salt iodization, goitre rate.

Introduction

Iodine deficiency in the human body leads to a spectrum of disorders which are now collectively referred to as iodine deficiency disorders (IDD).[1] Iodine-deficient children suffer from lack of concentration, impaired coordination and sluggishness, which results in poor school performance. It has been estimated that, on average, school children living in iodine-deficient areas have IQ levels which are approximately 13 points less than those of children living in areas with sufficient iodine.[2]

A total of 117 countries in the world are reported to have a problem with IDD. It is estimated that 1570 million people in the world today are at risk of iodine deficiency. This constitutes 29% of the world's population. Globally, the prevalence of goitre is estimated to be 12% of the world's population. The prevalence of goitre in the South-east Asia region varies from 7% in Mongolia to 44.2% in Nepal, with a mean of 13%.[3]

Until recently in the Maldives, it had been assumed that IDD did not pose a threat to public health. This was apparently based on the fact that the Maldives is a country of islands. The staple diet of the inhabitants is sea fish, which are usually rich in iodine. However, no systematic scientific surveys to assess the prevalence of IDD have been carried out in the Maldives. Recent study by members of this team in India's Nicobar Islands has shown that IDD are a public health problem.[4] This study was undertaken to assess the magnitude of IDD among school children aged 6–12 years using both clinical and biochemical indicators.

Methodology

The Republic of Maldives is an 820 km archipelago located south-west of Sri Lanka and India in the Indian Ocean. It is comprised of approximately 1200 islands, of which about 200 are inhabited. The islands are small, rarely exceeding 1 km^2, and low lying with an average elevation of 1.6 m above sea level. The islands are clustered into 26 natural atolls (grouped into 20 for administrative purposes). Over one-quarter of the country's total population of 235 000 live in Male, the administration centre.

This study was undertaken during June and July 1995. The outcome variables were goitre prevalence and urinary iodine excretion level (µg/dL). The study population was school children between the ages of 6–12 years. In general, these age groups correspond to school grades two and three.

EPI cluster sampling, as recommended by the Joint WHO/UNICEF/ICCIDD Consultation in November 1992, was used.[5] The sample size calculation for the survey was based on an estimated prevalence of 50% with a precision of 10% and an alpha error of 5%. Because cluster sampling design was used, a design effect of three was assumed. Based on this, the sample size was estimated to be 1200. This comes to 40 students per cluster for 30 clusters.

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All of the 200 inhabited islands were listed with their population. A total of 30 clusters were selected from these by population proportion to size. In each cluster, all school children in grades two and three were examined. As a result, some of the children above and below the age group planned were also studied. However, the sample size in the 8–10 years age group was adequate.

Informed verbal consent was obtained from each school principal, teachers of the classes involved and local village leaders. All children were clinically examined for goitre by one person. This opportunity was also used to train and validate other team members in clinical examination of goitre. The grading of goitre was done as per the classification recommended by the Joint WHO/UNICEF/ICCIDD Consultation.[5]

On the spot casual urine samples were collected from every tenth student using wide-mouth screw-capped plastic bottles. The first child in each school was selected randomly and then every tenth student was enrolled. Urinary iodine estimation was done using the wet ashing method described by Dunn *et al.*[6]

In addition, several samples of water from different sources such as rain water and ground water were also collected for estimation of iodine content. The iodine content in water was estimated using the method described by Karmarkar *et al.*[7] Salt samples, both packed and loose, were collected from the shops in the island for estimation of iodine content. The iodine content of salt was estimated using the titration method.[7] All of the laboratory work was undertaken in the ICCIDD laboratory in Delhi. The data were entered in the database and analysed using the EPI INFO package (Version 6; Centre for Disease Control and Prevention, Atlanta, GA, USA).

Information was gathered from a sample of the families on each island regarding their salt consumption and storage practices. In addition, the women were asked whether they predominantly consumed reef fish or tuna fish, and questioned about their methods of preparation.

Results

A total of 30 schools and 2834 school children in the seven atolls were surveyed. The highest number of students examined were from Seenu atoll (n = 640) and the lowest from Raafu (n = 239). The age and sex distribution of the study children is given in Table 1. Children in the age group of 8–10 years constituted the majority (69.2%) of the population. The prevalence of goitre in different age groups is given in Table 2. The overall prevalence of goitre was 23.6%. The prevalence of grade 1 goitre was 22.5% and grade 2 (visible) goitre was 1.1%. The prevalence of goitre was higher in children above 10 years of age. The prevalence of goitre among different sexes is given in Table 3. As was to be expected, girls had a higher prevalence of goitre (26.6%) than did boys (20.7%). However, as the sample size was calculated only for estimating the prevalence in the 8–10 years age group, the sample size may not have been adequate for making comparisons based on age and sex.

The distribution of urinary iodine levels is given in Fig. 1. A total of 316 urine samples were analysed for iodine content. Of these, 65.5% had iodine levels below the recommended level of 10 µg/dL. The median urinary iodine level was 6.70 µg/dL.

Table 1. Age and sex distribution of the study children

Age (years)	No. males	No. females	Total (%)
6–8	269	310	579 (20.5)
8–10	1010	953	1963 (69.2)
10–12	138	154	292 (10.3)
Total (%)	1417 (50)	1417 (50)	2834 (100)

Iodine content of water

The iodine content of water in the Maldives is shown in Table 4. The number of samples examined was small. However, this can be considered preliminary information. All of the water sources had high concentrations of iodine. The iodine content of well water was highest with a mean iodine content of 38.8 µg/L.

Table 2. Prevalence of goitre among school children by age

Age (years)	No. children	Prevalence of goitre (%) Grade 0	Grade 1	Grade 2	Total goitre rate (%)
6–8	579	78.5	20.8	0.7	21.5
8–10	1963	76.6	22.4	1.0	23.4
10–12	292	70.5	26.7	2.7	29.4
Total	2834	76.4	22.5	1.1	23.6

Table 3. Prevalence of goitre among school children by gender

Sex	No. children	Prevalence of goitre (%) Grade 0	Grade 1	Grade 2	Total goitre rate (%)
No. males	1417	79.3	20.1	0.6	20.7
No. females	1417	73.4	25.0	1.6	26.6
Total	2834	76.4	22.5	1.1	23.6

Table 4. Iodine content of water from different sources in the Maldives

Type of water	No. samples	Mean iodine content (µg/L)
Rain water	10	1.65
Well water	5	38.76
Ground water	3	6.17
Desalinated drinking water	1	2.90

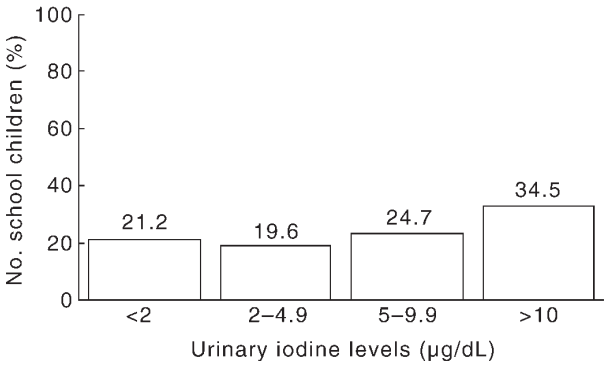

Figure 1. Distribution of urinary iodine levels in school children of the Maldives (n = 316).

Iodine content of salt samples

A total of 39 salt samples from different companies were collected. None of the samples from the companies of Siem Trading Company ($n = 7$) and Moon Star ($n = 4$) were iodised. Samples from Flying Man ($n = 28$), however, included three samples with an iodine content greater than 15 p.p.m., 19 samples with an iodine content of less than 15 p.p.m. and six samples with no iodine content. In general, the majority of salt samples analysed did not have adequate iodine content (i.e. 15 p.p.m. of iodine).

Rapid assessment of dietary practices related to iodine deficiency disorder and its control

In the rapid assessment conducted among a few families it was determined that the average consumption of salt was approximately 10–15 g per person per day. The salt was stored in plastic containers and covered. In most households it was kept near the fire place. Salt labelled as 'iodised' was available on only a few islands. In general, people did not eat reef fish, which are known to consume sea weeds rich in iodine. Rice and tuna fish formed the staple diet. In many places the head of the tuna fish, which by virtue of containing the thyroid gland of the fish is rich in iodine, was not used in cooking. Moreover, the fish was cooked unusually in open pots, which would lead to loss of iodine by evaporation.

Discussion

The grading of severity of IDD as a public health problem is based on the criteria recommended by WHO/UNICEF/ICCIDD.[5] The summary indicators and their interpretation is given in Table 5. According to these criteria, IDD appears to be a mild to moderate public health problem in the Maldives. Thus, contrary to the conventional wisdom, IDD poses a public health problem in island populations as well as mainland populations. This has also been demonstrated in the Nicobar Islands of India, as previously mentioned.

In the assessment of goitre by palpation, intra-observer variation is acknowledged, especially in the assessment between grade 0 and grade 1. The manifestation of goitre in a population is a function of several factors, including age at which iodine deficiency occurs, sex, and the severity, duration and status of iodine supplementation measures. In general, the prevalence of goitre in a population gives information about a region's historical status with respect to iodine deficiency. Urinary iodine estimation is more objective and less prone to observation errors. It gives information about the current status of iodine levels in a population.

Table 5. Summary indicators of iodine deficiency disorders in the Maldives

Indicator	Value	Severity of problem
Goitre prevalence (%)	23.60	Moderate
Median urinary iodine (μg/dL)	6.70	Mild

Even though fish is part of the Maldives diet, the fish type, portion or cooking method can mitigate against it as an effective iodine source.

The iodine content of water was found to be high. The concentration of iodide in sea water is approximately 50–60 μg/L. Water from deep wells can provide a major source of iodine. The rain water that returns iodine to the soil generally has iodine concentrations in the range of 1.8–8.5 μg/L.[8] One reason why an area could be iodine deficient is lack of iodine in its soil, which would be reflected in the ground water. In general, iodine-deficient areas have water iodine levels below 2 μg/L, as in Nepal and the state of Uttar Pradesh in India. According to the findings of this study, desalinated drinking water had lower concentrations of iodine, whereas well water was extremely rich in iodine.

By and large, the population of the Maldives was consuming salt which was either not iodised or inadequately iodised. Dietary habits also deprived the residents of the iodine present in sea foods. However, the salt storage practices were favourable for the retention of iodine in salt. Thus, the population of the Maldives definitely needs iodine supplementation measures.

The most common method of iodine supplementation is iodised salt. The Maldives has not yet introduced any intervention strategy for IDD control. The Maldives receives most of its salt requirement from private traders in Tamil Nadu in India. To date, no salt is produced in the Maldives. The results of this survey thus show the iodine content of salt in the absence of any conscious and deliberate efforts by the Government to increase iodine levels. The Maldives may require the introduction of legislation banning the import of non-iodised salt.

Because all of the atolls are affected, there is a need to introduce universal salt iodization in the Maldives. In order to have an effective program, the regular monitoring of iodine content in salt at the different stages of production, distribution and, in particular, at consumption level is essential. Given that the problem of iodine deficiency has only recently begun to be seen as important, efforts are still needed to increase awareness of the problem. There is a need to initiate a series of information, education and communication activities related to IDD among those groups which have a special interest in seeing the problem eliminated. These stakeholders, who include IDD experts, non-government organisations, salt industries, the Government, policy makers, professional communicators, educators, healthcare providers and agriculturists, would promote appropriate food habits, training, curriculum development, lobbying and salt standards etc. A resurvey using the same methodology should be carried out after a period of 3 years to assess the impact of the universal salt iodization program.

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Maldives 地區的缺碘症: 公共衛生問題

摘要

Maldives是一個島國, 過去缺碘症(IDD)一直不被認爲是一個公共衛生問題. 然而在Maldives 從未對IDD進行過系統的科學調查. 本調查是由Maldives共和政府與Maldives UNICEF 于1995年六月至七月聯合進行的首次IDD普查. 這一普查采用了WHO/UNICEF/ICCIDD聯合推薦的"EPI 30整群抽樣法". 根據人群比例, 從200島嶼中抽取了30組人群作爲普查對象. 來自30個小學的2,834 名年齡在6－12歲的兒童參與了這項普查. 總的甲狀腺腫大率（TGR)是23.6%, 其中I度甲狀腺腫大率 占22.5%. 女孩的甲狀腺腫大率(26.6%)比男孩(20.7%)要高. 尿碘水平的中位數爲6.7μg/dL, 65.5%的兒童尿碘水平低于10μg/dL. 這次普查的結果表明缺碘症是Maldives的一大公共衛生問題. 因此應該着手考慮控制IDD的措施. 最常用的補碘措施是碘鹽法. 在39個無代表性的食用鹽樣品中僅有8%的食鹽含碘量超過15 ppm. 由于缺碘症 遍及到 所有的珊瑚島嶼, 應采用全國性的碘鹽化措施來控制Maldives 的缺碘症問題.

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