Endemic goitre in schoolchildren in high and low altitude areas of Asir Region, Saudi Arabia

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ABSTRACT

Objective: A deficiency of iodine is characteristic of moutainous regions of the world, and the frequency of goitre in such areas has been recognized for centuries. The aim of the present study was to estimate the prevalence of goitre among schoolchildren in high and low altitude areas of Asir Region.

Methods: The study was carried out upon 940 male students randomly selected from 12 schools at 2 high altitude areas (Tamnia and Al-Soda) 3150 meters above sea level and one low altitude area (Marabah) 500 meters above sea level. All students were subjected to clinical examination of the thyroid and classification of goitre grading was based on the criteria endorsed by the World Health Organization/United Nations Children's Fund/ International Council for the Control of Iodine Deficiency Disorders.

Results: An overall prevalence of goitre of 24% was estimated in the areas studied (24% in elementary, 24% in intermediate and 23% in secondary education). This prevalence was significantly higher ($p<0.0001$) in high altitude (27%, 95% confidence interval: 24%-30%) than in low altitude areas (13%, 95% confidence interval: 8%-18%). Children of high altitudes were 2.5 times more likely to develop goitre as compared to their counterparts in low altitudes (odds ratio = 2.5, 95% confidence interval 1.6-3.8). However, comparison between the 2 high altitude areas revealed that children of Tamnia area were nearly 2 times more likely to develop goitre than their counterparts in Al-Soda (odds ratio = 1.9, 95% confidence interval: 1.3-2.6).

Conclusion: Endemic goitre is more prevalent in mountainous, high altitude areas of Asir Region. However, the distribution of goitre in these areas is patchy and differs from area to area. Well water might have been a contributing factor for the high prevalence in Tamnia.

Keywords: Endemic goitre, high/low altitude, prevalence, schoolchildren.

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By the end of 1996, 14 countries had carried out a survey of iodine deficiency disorders (IDD) to assess whether IDD was a problem in their countries. As a result of these studies and other data, 16 countries have identified IDD as a public health problem and have decided to iodize their salt.[1] Mapping Saudi Arabia for iodine deficiency through the epidemiological survey of school children has revealed adequate iodine status in all provinces except the Southern province.[2] A deficiency of iodine is characteristic of the mountainous regions of the world,[2] and the frequency of goitre in such areas had been recognized for centuries. On the other hand, lower incidences of colloid goitre at altitudes exceeding 3000 m in Peru were reported,[3] and it was concluded that the effects of high altitude, per se,

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appears to counteract the effects of iodine deficiency, resulting in a lower peripheral utilization of Thyroxin and hence, the general depression of thyroid function. The region of Asir, with a population of 1,200,000 covers more than 80,000 km^2 in Southwestern Saudi Arabia. Sharing its border with Yemen, the area extends from the high Asir mountains, almost 3200 m above sea level, down to the Red Sea. The aim of the present study was to estimate the prevalence of goitre among school children in high and low altitude areas of Asir Region.

Methods. The study was carried out at high and low altitude areas of Asir. At high altitude (3150 meters above sea level), Tamnia and Al-Soda areas were selected, while Marabah area was selected as a relatively low altitude (500 meters above sea level). Environmental data on these areas is shown in Table 1. The communities in the 3 selected areas are typical semi-urban and rural populations who nevertheless enjoy many of the facilities of modern life, such as electricity and cars, while retaining their basic dietary and social habits. Houses are generally of lower hygienic standards compared to those of urban communities. Meat, chicken and rice constitute the major dietary items, while seafoods are rarely served. The prominent source of dietary water is wells in Tamnia, while in Al-Soda and Marabah, desalinated water is the main source of drinking water. Health services are provided in the 3 areas by primary health care centres. All schools for boys available in the 3 selected areas were included in the study. These are 6 elementary, 3 intermediate and 3 secondary schools. Using the proportionate allocation method of sampling, 53 classrooms were selected to represent all the educational grades. All students in these selected classrooms constituted the target for the present study. These are 940 students. Clinical examination of the thyroid gland of each student was carried out through inspection and palpation. Examination was carried out for all students by the same surgeon for the sake of consistency. Classification of goitre grading was based on the criteria endorsed by World Health Organization/United Nations Children's Fund/ International Council for the Control of Iodine Deficiency Disorders (WHO/UNICEF/ICCIDD),[5] which are as follows: Grade Description: 0 - No palpable or visible goitre; 1 - A mass in the neck that is consistent with an enlarged thyroid that is palpable but not visible when the neck is in a neutral position. It also moves in the neck on swallowing; 2 - A swelling in the neck that is visible in a neutral position and is consistent with an enlarged thyroid when the neck is palpated. The sum of grades 1 and 2 was taken as the total goiter cases.

Data Analysis. Data was analyzed using the SPSS software program for cross-tabulation and computation. Prevalence of goitre was estimated for areas of the study, and their corresponding 95% confidence intervals were calculated. Statistical significance for the difference between prevalence rate of goitre among high and lowlanders was tested by Z-test. Chi-squared test was used for comparison of categorical data for both groups. Odds ratio (OR) was used to study the relationship between the prevalence of goitre and altitude. P-value less than 0.05 was considered significant.

Table 1 - Environmental data on the high and low land of the study.

	Tamnia and Al-Soda	Marabah
Altitude (meter)	3150	500
Barometric pressure (mmHg)	550	720
Atmospheric oxygen tension (mmHg)	110	145
Relative humidity (%)	20-30	50-90
Summer temperature (Shade) (degrees centigrade)	16-28	30-45
Winter temperature (Shade) (degrees centigrade)	5-15	25-35

Results. The results of the present study revealed an overall prevalence of goitre of 24% among all schoolchildren. This prevalence was significantly higher (X^2 =17.59, P<0.0001), among schoolchildren of high altitude areas (27%; 95% CI: 24%-30%) than among their counterparts in low altitude areas (13%, 95% CI: 8.4-17.6). Schoolchildren in the high altitude were 2.5 times more likely to develop goitre as compared to their counterparts in low altitudes (X^2 = 17.59, P < 0.001; OR = 2.5, 95% CI: 1.6-3.8). This higher prevalence among highlanders was evident in all grades of goitre (Table 2). Table 3 shows a significantly higher prevalence of goitre among schoolchildren of Tamnia (33%, 95% CI: 28%-37.5%) than among their counterparts in Al-Soda (21%, 95% CI: 16%-25%). Schoolchildren of Tamnia area were nearly 2 times more likely to develop goitre as compared to their counterparts in Al-Soda area (X^2 = 13.56, P < 0.001, OR = 1.9, 95% CI: 1.3-2.6). This higher prevalence among children of Tamnia was evident in all grades of goitre. Table 4 shows a significantly higher prevalence of goitre among highlander than lowlander schoolchildren of elementary (26.5% vs. 17%, OR = 1.7, 95% CI: 1.1-2.9; P < 0.05) and intermediate (30.5% vs. 4.5%, OR = 9.4, 95% CI: 2.8-31, P < 0.001) education but not in secondary education (24% vs. 16% OR = 1.7, 95% CI: 0.5-5.2, P >0.05). Meanwhile, the table shows

Table 2 - Prevalence, 95% confidence interval and grade of goitre among school children in high and low altitude areas of Asir region.

Grade	High-altitude (N=733) % (95% CI)	Low-altitude (N=207) % (95% CI)	Z-test	P-Value
0	73	87	4.74	<0.001
1	6 (4.6-8.2)	12 (-0.4-2.2)	3.17	<0.002
2	21 (17.8-23.6)	13 (8.4-17.6)	4.94	<0.001
Prev.	27 (23-30.3)	13 (8.4-17.6)	4.94	<0.001
$X^2 = 117.59$ ($P < 0.001$), OR = 2.5 (95% CI: 1.6-38) Prev - prevalence; N - number; CI - confidence interval; OR - odds ratio				

Table 3 - Prevalence, 95% confidence interval and grade of goitre among school children in 2 high altitude areas of Asir region.

Grade	Tamnia (N=390) % (95% CI)	Al-Soda (N=343) % (95% CI)	Z-test	P-Value
0	67	79		
1	8 (5.2-10.6)	4 (2-6.2)	2.19	<0.003
2	25 (20.9 - 29.2)	17 (12.7-20.5)	2.79	<0.001
Prev.	33 (28.1 - 27.5)	21 (16.4-25)	3.75	<0.001
$X^2 = 13.56$ ($P < 0.001$), OR = 1.9 (95% CI: 1.3-2.6) Prev - prevalence; N - number; CI - confidence interval OR - odds ratio				

Table 4 - Prevalence (%) of endemic goitre among school children of different educational levels in high and low altitude areas of Asir Region.

Educational level	High Altitude			Low Altitude
	Tamnia	Al-Soda	Total	Marabah
Elementary N Cases (Prev.)	68 (34)	31 (18)	99 (26.5)	20 (17)
OR (95% CI) P-Value	2 (1.4-3.8)[a] <0.005		2 (1.1-2.9)[b] <0.05	
Intermediate N Cases (Prev.)	44 (36)	18 (22.5)	62 (30.5)	3 (4.5)
OR (95% CI) P-Value	2 (1.1-3.6)[a] <0.05		9 (2.8-31)[b] <0.001	
Secondary N Cases (Prev.)	16 (24)	22 (24)	38 (24)	4 (16)
OR (95% CI) P-Value	1.0 (0.5-2.1)[a] >0.05		2 (0.5-5.2)[b] >0.05	
OR - Odds ratio; CI - confidence interval a - statistical difference between Tamnia and Al-Soda areas' prevalence b - statistical difference between high and low altitude areas' prevalence				

significantly higher prevalence of goitre in Tamnia than in Al-Soda among schoolchildren in elementary (34% vs. 18%, OR = 2.3, 95% CI: 1.4-3.8, $P < 0.005$) and intermediate (36% vs. 22.5%, OR = 1.9, 95% CI: 1.1-3.6, $P < 0.05$) education, but not in secondary education (OR = 1.0, 95% CI: 0.5-2.1, $P > 0.05$).

Discussion. Implementing practical and effective surveillance is essential to determine the prevalence of IDD and to identify high-risk population and risk factors. Communities to be surveyed must be truly representative, as the worst IDD is typically in areas that are poor, rural, isolated and uneducated.[6] These factors make these areas difficult to reach in a national survey, and they are often overlooked in favor of more accessible sites, thus misrepresenting the true severity of the iodine deficiency. In the present study trying to study endemic goitre in a mountainous, rural, relatively less accessible area of Asir Region revealed an overall high prevalence of goitre of 24%. Based upon the WHO criteria of endemicity of goitre,[7,8] our data considers this area of the Kingdom as an endemic area of goitre. This is in an agreement with the findings of a national epidemiological survey that reported the highest prevalence in the Southern Province.[2] The frequency of goitre in mountainous areas has been recognized for centuries. In England it was known as "Derbyshire neck" indicating the high incidence of goitre in limestone area. It was equally well known in the Alps, the Andes and the Himalayas but it is not confined to the mountains.[3,4] In the present study, the prevalence of goitre among schoolchildren in high altitude areas of 3150 m was significantly higher than the prevalence among their counterparts in low altitude areas of 500 m. This finding was persistent in all grades of goitre among school children of all educational levels. This may be attributed to the hypothetical association of iodine deficiency and mountainous regions. There are 2 main possible explanations. First, it has been reported that soils in mountains are poor in iodine due to the effect of heavy rains that characterize such areas. When ice thaws, the iodine-rich soil is swept away and replaced by new soil derived from iodine poor crystalline rocks. Secondly, it appears that these mountainous areas may not have access to seafood or food with high iodine content, making them susceptible to the development of goitre.[2,9] Although the dietary pattern of school children in the present study was not investigated, iodine-rich foods such as fish are rarely or even not consumed at all, as reported by the school children. Green vegetables are included in the daily diet of such communities, but their contribution to the daily iodine intake varies according to the content and availability of iodine in the soil on which the vegetables were grown. Patchy distribution of goitre in the population of the

mountainous areas has been reported, with no universal distribution through such population at risk.[4] This was in agreement with the results of the present study, where the prevalence of goitre among school children of the high altitude area of Tamnia was significantly higher than the prevalence among their counterparts in the Al-Soda area, an area of the same altitude, a finding that may reflect the presence of factors other than the lack of exogenous iodine. This patchy distribution of goitre in mountainous areas was attributed to 2 main factors; ingestion of goitrogenic foods or compounds that block thyroglobulin synthesis, and genetic defects involving enzymes vital to the elaboration of thyroid hormones.[4] In the present study, people of Tamnia, the high altitude area of the high prevalence of goitre, depend mainly upon wells water for drinking, as compared to the Al-Soda area, the high altitude area of the lower prevalence where desalinated water is the main source of drinking water. Well water might have acted as a goitrogenic, although further studies are recommended to test this hypothesis.

In conclusion, endemic goitre is more prevalent in mountainous, high altitude areas of Asir Region. However, the distribution of goitre in these areas is patchy and differs from area to area. Although mountainous areas may predispose to endemic goitre mainly through lack of iodine intake, possible effects of high altitude per se need further investigation. There are 2 complicating factors in the study of this effect under natural conditions; the first is that mountain regions are often deficient of iodine, and the 2nd is that a cold environment affects thyroid function. These variables are much easier to control in experimental animal than in man.

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