Anemia and nutritional status of schoolchildren living at Saudi high altitude area

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ABSTRACT

Objective: To estimate the prevalence and possible risk factors for anemia and abnormal anthropometric measurements among schoolchildren in Al-Hada Area, Taif, Kingdom of Saudi Arabia.

Methods: We conducted the study between January and April, 2005 at Al-Hada area. A nested case-control study was conducted to estimate risk factors for anemia and abnormal anthropometric measurements.

Results: From 5 schools, 513 students were recruited. The mean hemoglobin concentration was 13.4±0.9 g/dL, while the prevalence of anemia was 11.6% and 15.5% based on hemoglobin and hematocrit values. At the same time, underweight affected 14.2% of the students, and stunting affected 12.2%. Moreover, 9.8% of the students were obese and 13.8% suffered from wasting. Most of the victims of anemia and erroneous anthropometric measurements were females, except for wasting which was more prevalent among males.

Conclusion: Anemia is highly prevalent among these schoolchildren, which is seriously affecting the growth of 6-14 year-old children. Similarly, malnutrition seems to be a significant health problem among those children as estimated by anthropometric measurements, where all forms of abnormal body measurements affected at least 9.8% of the studied group. An in-depth investigation of the etiological factors of iron deficiency and malnutrition is urgently needed, and suitable nutrition-education and iron supplementation programs are recommended.

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Malnutrition permeates all aspects of health, growth, cognition, motor, and social development of young children in developing countries. Irreversible and lifelong sequelae prevent children from reaching their full potential.[1] Iron deficiency anemia (IDA) is still a major nutritional and public health problem in developing countries with a particularly high prevalence among young children.[2] Yet, being anemic has important consequences for all age groups. A review of studies of school-age children, the vulnerable group to the effects of ill health during the growing and learning stages, shows that anemia can affect cognitive function, motor performance and educational achievements.[3] In a study conducted in the Pacific countries; it was found that the prevalence of anemia was 12.4%. Children with anemia and helminthic infestations were found to be 8.7 times more likely to be stunted, and 4.3 times more likely to be underweight than non-anemic and non-infested children.[4] It is well established that highlanders have optimized their oxygen transport system, and with altitude acclimatization, blood hemoglobin concentration increases.[5] An increase of 11% in total hemoglobin mass, as well as a corresponding increase

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in red cell volume (RCV), hemoglobin concentration and hematocrit values at altitude of 3,550 meter above sea level were recorded.[5] Similarly, a difference in hemoglobin concentration between sea-level residents and moderate-altitude residents at 2500 meter above sea level was estimated to be approximately 12%.[6] Initially on traveling to high altitude areas, hemoglobin concentration rises through a fall in the plasma volume due to dehydration. Later, hypoxia stimulates production of erythropoietin by the juxtaglomerular apparatus of the kidney, so hemoglobin production increases and hemoglobin concentrations may rise up to 20 g/dL.[7] No data were available regarding the prevalence of anemia among schoolchildren in Taif, and also regarding their anthropometric measurements that could be affected if they are anemic. Such data, if available, would guide the preventive medicine activities for that group. This study aimed to estimate the prevalence and possible risk factors for anemia and abnormal anthropometric measurements among schoolchildren in Al-Hada Area, Taif, Kingdom of Saudi Arabia.

Methods. The study was conducted as a nested case-control study. It started as a screening cross-sectional descriptive study involving primary school students enrolled in the program of Al-Hada and Taif Armed Forces Hospitals, Taif, Kingdom of Saudi Arabia. The program included 9 primary schools (6 for boys with 75 classes including 1800 students, and 3 for girls with 31 classes including 783 students). According to the results of screening for anemia, weight for age, height for age, and body mass index (BMI) for age, cases were categorized as those students with abnormal figures, namely, anemic, stunted, obese, underweight, or wasted. For each case, 3 controls were randomly selected and compared to identify possible risk factors.

Survey of schoolchildren. The study was conducted between January and April, 2005 at Al-Hada Area. Al-Hada is located in the Taif Mountains (Western region of Saudi Arabia) at an altitude of 6000 feet (1,800 meters) above sea level. At this high altitude, oxygen is less readily available.

Study population and data collection. Approximately 20% of primary school students enrolled in the program of Al-Hada and Taif Armed Forces Hospitals were recruited in this study. Three out of 6 male primary schools, and 2 out of the 3 female primary schools were selected randomly to be included in the study. Moreover, a simple random sample of classes was used. At each school, we included a number of schoolchildren selected in proportion to the number of students enrolled in each school. The total desired number of students from each school was divided over the 6 grades to include students with age from 6 up to 13 years old. Participants' data were collected using a questionnaire developed specially for the survey. A blood sample was taken from all participants after the guardian signing informed consent.

Nested case-control. Cases and controls were identified according to the results obtained from the survey after performing the measurements. Cases were those students with anemia, and abnormal anthropometric measures. Controls were selected from students with normal measurement with a ratio of 1 case: 3 controls. Anemic cases were defined as those who have a hemoglobin concentration less than 12.15 g/dl for children between 6-11 years of age, and less than 12.65 g/dl for children ≥12 years of age. Controls were selected from those who have a hemoglobin concentration of ≥12.15 and 12.65 g/dl for the above-mentioned age groups, regardless of gender. Regarding hematocrit value, it was corrected for high altitude at cut-off values for anemia of 36% and 38% for those from 6-11 years and those above 11 years. Hemoglobin concentrations and hematocrit values were measured, and the prevalence of anemia was examined using the recently revised UNICEF/WHO thresholds for the school-age group after being corrected based on the high altitude of Al-Hada zone (1800 meter above sea level).[8] For each case, 3 controls were randomly selected and matched for classroom and age ±1 year.

Data collection. The study procedures were approved by the Research and Ethics Committee of Al-Hada Armed Forces Hospital. Informed consent was obtained from parents of students before the data collection. Interviews were conducted with the parents of recruited students using a pre-coded questionnaire developed for the study. The questionnaire covered personal, socio-demographic data, crowding index (number of family members/number of rooms in dwelling), period of residency in Al-Hada area, medical history and other risk factors, health and some dietary habits, such as eating breakfast regularly before school, drinking tea or coffee following meals or being on a diet for weight reduction. No other details of dietary habits were collected. Weight was measured in kilograms using a 160-kg capacity Detecto scale with increments of 100 grams. A vertical measure rod with a length of 200 cm and a precision of 0.1 cm was used for measuring height. The students were weighed without shoes, standing on the center of the scale without touching anything around. The weight was measured to the nearest 0.5 kilogram. Height was measured by the same scale to

the nearest cm. The WHO/NCHS reference standards were used to convert anthropometric measurements into indicators in the form of weight-for-age, height-for-age and BMI-for-age. Z score values were used in the analysis.[9] Three schools for boys were randomly selected; they were King Fahd, Amir Abdul-Rahman and Al-Abnae schools, and 2 for girls (Al-Abnae and Al-Hada).

Blood and stool examination. Blood samples were collected by venipuncture with analysis by automated cell counter. Stool containers for stool examination were distributed the day prior to the survey to obtain a fecal sample. Samples were fixed the same day with 10% formol-saline, and the volumetric concentration technique was used the following day. Any parasitic cysts or ova seen on x10 and x 40 microscopy would be recorded.

Sample size. The estimated sample size to determine the prevalence of anemia was 513, assuming that the prevalence of anemia was 10% with a precision of ±3 at 95% confidence level. This sample size was increased to 550 to compensate for the expected dropout. The actual number of blood samples collected was 465, which represents a response rate of 90.6%. To estimate the prevalence of intestinal parasites, it was planned to collect stool samples for half of the recruited students. The actual number of stool samples collected was 122, which represent a response rate of 49.9%.

Statistical analysis. Data were analyzed using SPSS version 11.0 software. Cases and matched controls were compared in terms of risk factors using univariate analysis. Odds ratios (OR) and 95% confidence intervals (CI) were estimated and variables whose level were statistically significant ($p<0.05$) on univariate matched analysis were entered jointly into a multivariate conditional logistic regression. Statistical significance was determined by likelihood tests.

Results. The selected sample represented the 6 grades in the primary stage, with the percent of each stage represented ranging between 12.5-26.3% of the sample. As shown in **Table 1**, the males represented 72.1% of the sample and the females were 27.9%, which is nearly their population ratio within the primary schools. Most of the students were Saudi and nearly three-quarters of them spent the last month before their participation in the study at a high altitude in the Al-Hada Area. Regarding socioeconomic status of the students, approximately half of their fathers finished secondary school education, 26.3% had a university degree, and the majority was militants working at the Airbase. Conversely, their mothers were less educated, and only 18.8% of the mothers had regular jobs. Regarding their income, 50.6% of them stated that they usually can save part of their monthly income. Crowding index was relatively good as in 82.8% of cases, crowding index was less than 2 persons per room. The mean hemoglobin concentration was 13.3±0.9 g/dL for the entire studied group. Similarly, mean of hematocrit value for the entire group was 40.4±2.6%. These estimates were similar comparing the 2 age groups presented in **Table 2** ($p>0.05$). Measuring hemoglobin and hematocrit values for students as indicators for anemia revealed that 54 students (11.6%) had hemoglobin level below normal, while hematocrit value revealed 72 (15.5%) students as anemic. Anthropometric measures showed that 72 (14.2%) of the students are underweight for their ages and 62 (12.2%) of them are stunted, while BMI for age revealed that 50 (9.8%) of the students are obese (BMI above 95th percentiles for their age) and 108 (21.2%) of them are at risk of obesity (BMI between 85th and 95th percentiles for their age) and lastly 70 (13.8%) are wasted (BMI below the 5th percentile for their age). Surprisingly, stool analysis for 122 students (23.7% of the studied population and 49% of the proposed stool samples to be collected) showed that none of the students were infected with any kind of intestinal parasites. To detect possible risk factors for anemia and aberrant anthropometric measurements, 6 nested case-control analyses were conducted, where for each case of anemia based on hemoglobin and hematocrit values, underweight, stunted, obesity and wasting, 3 normal controls out of the study population were randomly selected and the analysis was performed accordingly. Anemia based on hemoglobin concentration adjusted for high altitude was significantly associated with spending the last month at sea level, practicing sports and history of chronic diseases. It was nearly twice as common among those who spent the previous month at sea level and among those who do not practice any kind of sports, and lastly it was 3 times more common among patients suffering chronic disease such as heart, kidney or liver diseases. Gender, socio-economic indicators, drinking tea or coffee after meals, eating breakfast regularly, and suffering acute disease in the previous month was not associated with anemia. The confounding effect of other risk factors on those factors significant by the univariate analysis was examined by logistic regression analysis. After adjustment, the 3 factors were found to turn into non-significant showing no effect of those factors on hemoglobin. On the other hand, crude odds ratios for risk factors for anemia based on hematocrit level adjusted for high altitude showed no association with

Table 1 - Demographic profile of the studied population.

Demographic profile	n	(%)
Age (mean ± SD)	9.7 ± 1.9	
Gender		
Male	370	(72.1)
Female	143	(27.9)
Grades		
Grade 1	64	(12.5)
Grade 2	70	(13.6)
Grade 3	71	(13.9)
Grade 4	79	(15.4)
Grade 5	94	(18.3)
Grade 6	135	(26.3)
Nationality		
Saudi	498	(97.1)
Non Saudi	15	(2.9)
Father education		
Illiterate /read-write	10	(2)
Primary schooling	11	(2.1)
Intermediate schooling	103	(20.1)
Secondary schooling	254	(49.5)
University	135	(26.3)
Father occupation		
Military	409	(79.7)
Civilian	87	(17)
Retired	17	(3.3)
Mother education		
Illiterate /read-write	88	(17.2)
Primary schooling	52	(10.1)
Intermediate schooling	113	22.1)
Secondary schooling	149	(29.1)
University	111	(21.6)
Mother occupation		
Working	96	(18.7)
Not working	417	(81.3)
Income		
Enough and saving	259	(50.5)
Just enough	233	(45.4)
Not enough	21	(4.1)
Crowdness index (CI)		
<2	424	(82.7)
≥2	89	(17.3)

any of the above-mentioned factors. Surprisingly, adjustment for risk factors showed significant association between anemia and gender being 6 times more common among females. Also, practicing sports has a protective effect, where anemia was 10 times more in sedentary students. Contrarily, being on a diet for weight reduction is associated with anemia, which was nearly 10 times more common among students on diet for weight reduction (**Table 3**).

Anthropometric measures in the form of weight-for-age, height-for-age, and BMI-for-age were estimated for each recruited student. Cut-off points for anthropometric measurement were determined using standard deviation scores or Z scores, where normal figures lie between ± 2SD (**Tables 4 & 5**). The association between possible risk factors and anthropometric measurements was examined using the Mantel Heinzel test for estimation of crude odds ratios. Adjustment was then carried out using logistic regression analysis to alleviate the effect of possible confounders. Weight-for-age Z scores were associated with suffering acute diseases, such as diarrhea, and was also associated with anemia. Crude odds ratios revealed that being underweight is nearly 3 times more prevalent among students that suffered acute disease over the previous month, and moreover, twice more common among anemic students. After adjustment using logistic regression analysis, acute diseases over the previous month were still significantly related to underweight. Height-for-age Z scores were only related to gender as stunted growth was twice more common among females. After adjustment, this relation was much more prominent, where stunting was 3.5 times more prevalent among females. In addition, eating breakfast was found to be protective against stunting, being nearly 3 times less common among those who eat breakfast regularly (**Table 4**). Obesity and wasting among students were assessed

Table 2 - Hemoglobin concentration and hematocrit value according to age of the studied schoolchildren.

Hematological variables	Age in years*				
	≤11 years (n=353)		>11 years (n=112)		Total group (n=465)
	Males	Females	Males	Females	
Hemoglobin (g/dL)					
Mean ± SD	13.3 ± 0.9	13.3 ± 0.9	13.6 ± 0.9	13.3 ± 0.8	**13.4 ± 0.9**
Minimum - maximum	11.0 - 18.5	10.8 - 15.7	11.6 - 15.8	11.4 - 15.0	**10.8 - 18.5**
Hematocrit (%)					
Mean ± SD	39.8 ± 2.6	40.4 ± 2.9	41.0 ± 2.5	41.2 ± 2.4	**40.2 ± 2.6**
Minimum - maximum	34.2 - 54.3	32.5 - 49.1	35.8 - 46.5	36.2 – 47.8	**32.5 - 54.3**

* The cut off point for age presented in this table was chosen because age at this cut off level could affect hemoglobin concentration and hematocrit value

using BMI-for-age where an obese or wasted student was defined as any student where his BMI-for-age was above the 95th percentile, or below the 5th percentile. Obesity was strongly related to sedentary life, where it was up to 51 times more common among sedentary students compared to those who practice any kind of sports on regular basis. In addition, obesity was less common among students living in more crowded houses. Wasting is the only abnormal measurement that was more common among males. It was nearly 3 times more common among males compared to females after adjustment (**Table 5**).

Discussion. In this study, the prevalence of anemia is lower than most similar studies conducted in developing countries in Africa and Asia. Flora[10] stated that the prevalence of anemia is highest in Asia (58.4%) followed by Africa (49.8%). For example, anemia in Tanzania was estimated to affect 57% while it was 38% in Ghana.[11] In addition, Reiko[12] estimated the prevalence of anemia among primary schoolchildren in a province in Brazil to be 26.7%. In the Arab region, the prevalence of iron deficiency anemia among schoolchildren in Morocco was estimated at 35%.[13] Comparable to our results, a figure of 12.8% was recorded in Qena, Upper Egypt.[14] In Saudi Arabia, Abalkhail and Shawky[15] estimated that anemia affects 20.5% among schoolchildren in Jeddah, KSA including governmental and private schools, but was more prevalent among students in governmental schools and among low social class students. The lower prevalence of anemia in this study compared to other developing countries could be due to the pattern of food consumption among the Saudi population where, a lamb and rice meal is the most popular food (Kabsa) that is consumed regularly, and in any celebration or social gathering. Also, the socio-economic standard of Saudi people is high compared to other developing countries. In Saudi Arabia, the gross domestic product per capita

Table 3 - Risk factors for anemia based on hemoglobin concentration and hematocrit value both adjusted for living at high altitude.

Risk factors	Hemoglobin			Hematocrit		
	Anemia/ Control N=54/162	Crude OR (95% CI)	Adjusted OR (95% CI)	Anemia/ Control N=72 /216	Crude OR (95% CI)	Adjusted OR (95% CI)
Gender						
Male	35/114	1	Variable removed	53/154	1	
Female	19/48	1.29 (0.67-2.48)		19/62	0.89 (0.49-1.63)	6.60 (1.24-35.16)*
Staying at Al-Hada over the last month	32/120	2.13 (1.1-4.13)*	2.11 (0.93-4.78)	48/155	1.27 (0.70-2.29)	
Father education						
Preparatory or less	13/33	1	Variable removed	15/53	1	Variable removed
Secondary or high	41/129	1.21 (0.5-2.59)		57/163	0.83 (0.44-1.59)	
Father job						
Militant	40/129	1		56/173	1	Variable removed
Civil	14/33	1.35 (0.65-2.83)	2.17 (0.87-5.42)	16/43	1.1 (0.55-2.06)	
Mother education						
Preparatory or less	22/72	1	Variable removed	28/98	1	Variable removed
Secondary or high	32/90	0.89 (0.47-1.67)		44/118	0.8 (0.46-1.38)	
Mother job						
Working	8/25	1	Variable removed	13/36	1	Variable removed
Housewife	46/137	1.04 (0.44-2.47)		59/180	0.87 (0.43-1.76)	
Income						
Save	31/83	1	Variable removed	40/112	1	Variable removed
Don't save	23/79	0.83 (0.45-1.55)		32/104	0.9 (0.54-1.58)	
Crowding index						
<1.5	36/98	1	Variable removed	48/126	1	Variable removed
>1.5	18/64	0.71 (0.37-1.38)		24/90	0.7 (0.39-1.25	
Practicing sports	41/141	2.29 (1.02-5.15)*	2.51 (0.93-6.80)	58/191	1.72 (0.81-3.66)	0.11 (0.02-0.62)*
Drinking tea after meals	21/73	0.85 (0.45-1.62)	Variable removed	33/92	1.23 (0.71-2.12)	Variable removed
Drinking coffee after meals	7/25	0.84 (0.34-2.1)	Variable removed	10/32	0.95 (0.44-2.06)	Variable removed
On diet for weight reduction	5/13	1.21 (0.41-3.57)	Variable removed	7/15	1.56 (0.61-4.00)	0.13 (0.03-0.52)*
Eating breakfast	32/115	1.38 (0.68-2.82)	Variable removed	44/154	1.27 (0.69-2.35)	Variable removed
Suffering chronic disease	11/13	3.0 (1.25-7.25)*	2.60 (0.91-7.45)	11/25	1.41 (0.65-3.04)	Variable removed
Suffering acute disease (last month)	11/31	1.1 (0.51-2.40)	Variable removed	14/43	0.96 (0.49-1.9)	Variable removed

*$p<0.05$

Table 4 - Risk factors and its relation to weight and height measures of the studied group.

Risk factors	Weight for age Z-score			Height for age Z-score		
	Underweight/ Control N=72/216	Crude OR (95% CI)	Adjusted OR (95% CI)	Stunted/ Control N=62 /186	Crude OR (95% CI)	Adjusted OR (95% CI)
Gender						
Male	56/155	1.0	Variable removed	33/131	1.0	
Female	16/61	0.71 (0.38-1.34)		29/55	2.09 (1.16-3.78)*	3.55 (1.44-8.79)*
Father education						
Preparatory or less	20 /52	1.0	Variable removed	12/52	1.0	Variable removed
Secondary or high	52/164	1.21 (0.66-2.22)		50/134	1.59 (0.78-3.22)	
Father job						
Militant	59/171	1.0	Variable removed	52/151	1.0	
Civil	13/45	0.84 (0.42-1.66)		10/35	0.85 (0.40-1.85)	0.30 (0.08-1.16)
Mother education						
Preparatory or less	32/96	1.0	Variable removed	28/77	1.0	Variable removed
Secondary or high	40/120	1.0 (0.59-1.71)		34/109	0.85 (0.47-1.51)	
Mother job						
Working	14/41	1.0	Variable removed	9/33	1.0	Variable removed
Housewife	58/175	0.97 (0.49-1.91)		53/153	1.28 (0.57-2.85)	
Income						
Saves	37/108	1.0	Variable removed	36/96	1.0	Variable removed
Don't save	35/108	0.95 (0.55-1.62)		26/90	0.76 (0.43-1.37)	
Crowding index						
<1.5	43/133	1.0		43/118	1.0	Variable removed
>1.5	29/83	1.13 (0.65-1.95)	Variable removed	19/68	0.81 (0.43-1.51)	
Practicing sports	62/184	0.99 (0.46-2.14)	Variable removed	49/160	1.63 (0.76-3.50)	Variable removed
On diet for weight reduction	6/18	1.01 (0.38-2.65)	Variable removed	5 /12	1.32 (0.45-3.94)	Variable removed
Eating breakfast	53/160	1.01 (0.55-2.01)	Variable removed	48/131	0.77 (0.38-1.55)	0.34 (0.12-0.99)*
Suffering chronicdisease	7/30	0.68 (0.28-1.63)	Variable removed	5/27	0.54 (0.20-1.49)	Variable removed
Suffering acute disease (last month)	24/32	2.85 (1.52-5.32)*	2.44 (1.18-5.06)*	12/42	0.83 (0.41-1.72)	Variable removed
Anemia based on Hb	12/17	2.34 (1.05-5.20)*	2.32 (0.91-5.91)	8/21	1.08 (0.45-2.58)	Variable removed
Anemia based on hematocrit	12/27	1.39 (0.66-2.93)	Variable removed	8/28	0.77 (0.33-1.79)	Variable removed

*p<0.05, CI - confidence interval, OR - odds ratio

Table 5 - Risk factors and its relation to BMI measures of the studied group.

Risk factors	BMI-A Obese			BMI-A wasted		
	Obese/ control N=50/150	Crude OR (95% CI)	Adjusted OR (95% CI)	Wasted/ Controls N=70 /210	Crude OR (95% CI)	Adjusted OR (95% CI)
Gender						
Male	28/117	1.0	Variable removed	60/154	1.0	
Female	22/33	2.79 (1.41-5.49)*		10/56	0.44 (0.21-0.91)*	0.30 (0.10-0.88)*
Father education						
Preparatory or less	18/33	1.0	Variable removed	16/48	1.0	Variable removed
Secondary or high	32/117	0.51 (0.25-1.01)		54/162	1.0 (0.53-1.90)	
Father job						
Militant	36/118	1.0	Variable removed	57/172	1.0	Variable removed
Civil	14/32	1.48 (0.71-3.08)		13/38	1.03 (0.51-2.07)	
Mother education						
Preparatory or less	23/61	1.0	Variable removed	38/102	1.0	Variable removed
Secondary or high	27/89	0.81 (0.43-1.55)		32/108	0.80 (0.46-1.37)	
Mother job						
Working	8/28	1.0	Variable removed	9/39	1.0	Variable removed
Housewife	42/122	1.22 (0.51-2.87)		61/171	1.55 (0.71-3.38)	
Income						
Saves	23/84	1.0	Variable removed	37/112	1.0	Variable removed
Don't save	27/66	1.56 (0.81-3.01)		33/98	0.96 (0.56-1.66)	
Crowding index						
<1.5	33/85	1.0	0.26 (0.07-0.96)*	42/131	1.0	Variable removed
>1.5	17/65	0.62 (0.32-1.23)		28/79	1.12 (0.64-1.96)	
Practicing sports	34/137	5.0 (2.16-11.75)*	51.4 (5.17-511.4)*	62/183	0.80 (0.33-1.92)	Variable removed
On diet for weight reduction	6/9	2.98 (0.77-6.87)	Variable removed	4/12	1.09 (0.34-3.50)	Variable removed
Eating breakfast	32/110	1.43 (0.70-2.94)	Variable removed	50/151	0.80 (0.41-1.56)	Variable removed
Suffering chronic disease	4/15	0.89 (0.28-2.84)	Variable removed	5/27	0.53 (0.19-1.43)	Variable removed
Suffering acute disease (last month)	4/30	0.34 (0.11-1.03)	Variable removed	13/28	1.87 (1.01-3.45)*	Variable removed
Anemia based on Hb	6/14	1.52 (0.55-4.25)	0.09 (0.01-1.30)	8/26	0.91 (0.39-2.13)	Variable removed
Anemia based on Hematocrit	9/19	1.77 (0.73-4.26)	Variable removed	8/35	0.64 (0.28-1.46)	Variable removed

*p<0.05, CI - confidence interval, OD - odds ratio, BMI - body mass index

income equals 12,389 US$, while it is equivalent to 1,302 US$ in Ghana and 3,891 US$ in Egypt.[16] Comparing the prevalence of anemia in Saudi studies, the rate estimated in Jeddah,[15] was consistent with that estimated in this study, considering the differences in socioeconomic standards of the study population in the 2 researches. Over the years, significant progress has been made in improving the health and nutrition status of the people of the Eastern Mediterranean Region. The proportion of underweight, wasted and stunted children have all decreased as a whole, but with some inter-country variations.[17-18] A study conducted among schoolchildren in Saudi Arabia found that the prevalence of obesity was 13.5%.[19] In another study, the overall prevalence of obesity was 15.8% among schoolchildren aged 6-18 in Saudi Arabia and it was increasing with age.[20] Moreover, Abahussain et al[21] estimated that 28% of adolescent girls in Al-Khobar city are overweight or obese. In this study, the prevalence of overweight was 21.2%, while obesity was 9.8% among primary schoolchildren. This is quite similar to the previously mentioned figures. Again, the possible difference in socioeconomic characteristics of the study population in this study being militants in most of the cases, could explain the minor differences between this study and others. Underweight was estimated to affect 11% of adolescent girls in a previous study.[21] In our study, the rate was 14.2% which is close to the previously given figure. Most of the victims of anemia and erroneous anthropometric measurements were females, except for wasting which was more prevalent among males. We could not estimate any relation between anemia and abnormal anthropometric measures on one hand, and faulty dietary habits as drinking tea, coffee after meals, most of socio-demographic indicators, and eating breakfast regularly on the other hand. A larger study recruiting more students is recommended to examine these relations.

This study was conducted where the study population represents a specific group of the Saudi community, which is the military community but may not be representative for the whole Saudi community. The socioeconomic characteristics of the military community could explain the non-representativeness of this group to the Saudi community in general. Nevertheless, this study could be unique in exploring the situation of important health problems affecting Saudi schoolchildren in the military community. The questionnaire used did not cover details of dietary habits that enable full dietary assessment as our objective of this study did not include collecting full dietary history, and we used anthropometric measures to judge the nutritional status. In this study, the National Center for Health Statistics (NCHS) growth curves were used for comparison without adjustment for local use. The adjustments suggested by some authors as Al-Mazrou et al[22] and Abolfotouh et al[23] for the American curves involved children from 0-5 years, but no suggestion for adjustment was set up for school-age children. In our study, we estimated that the prevalence of parasitic infection as 0.0%. The number of samples (122 samples) and the response rate (49.9%) are major weaknesses regarding this estimate. In 1990, the Giardia lamblia was found to be a common intestinal parasite among children of all classes, *Entamoeba* histolytica followed among children of middle class, and *Hymenolepis nana* among those of lower classes in Abha, Saudi Arabia.[24] A larger sample for analysis of intestinal parasites among schoolchildren is recommended.

To conclude, anemia is highly prevalent among these schoolchildren, which seriously affects the growth of 6-14 year-old children. Similarly, malnutrition seems to be a significant health problem among those children as estimated by anthropometric measurements, where all forms of abnormal body measurements affected at least 9.8% of the studied group. In fact, females suffer the most from these health problems compared to male students. An in-depth investigation of the etiological factors of iron deficiency and malnutrition is urgently needed, and meanwhile suitable nutrition-education programs and iron supplementation programs are recommended.

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