



Nutritional Assessment and Vitamin D Deficiency among adolescent Students in Almarj, Libya

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KEYWORDS

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ABSTRACT:

Background: The prevalence of vitamin D deficiency is a worldwide public health issue. Adolescents are most at risk of vitamin D deficiency due to lifestyle habits, growth phases, and dietary considerations. The purpose of this research was to document the most prevalent nutritional and hematological concerns in Almarj, Libya, specifically the vitamin D deficiency pattern and potential determinants.

Methods: A total of 140, 12–18-year-old students in Almarj, participated in the cross-sectional study. The standard biochemical measurements for vitamin D, hemoglobin, and ferritin were performed and documented. BMI was estimated from anthropometric data collected during measurements, and lifestyle, chronic illness, and physical activity data were collected through tailored questionnaires. Data were analyzed statistically using a significance level of 0.05, in SPSS v25.

Results: The average level of vitamin D in the sample was 21.65 ± 7.54 ng/mL, and the average for males was statistically greater than females (24.26 ± 6.98 vs. 19.47 ± 7.57 ng/mL; $p = 0.03$). The average hemoglobin level of the total sample was 11.86 ± 1.86 g/dL, this was statistically lower in males ($p = 0.02$). Ferritin concentrations were significantly lower in females ($p = 0.12$). The BMI distribution data showed that a greater prevalence of females were overweight and obese ($p < 0.001$). Anemia that correlated with the perceived health of the subject and physical inactivity was statistically significant ($p < 0.05$). Anemic students reported headaches (52.9%), fatigue (55.7%), and tachycardia (44.3%).

Conclusion: Among adolescents, the documented vitamin D deficiency and anemia in Almarj is particularly concerning for females. Preventing long-term complications requires the use of public health measures centered on dietary diversity, supplementation, and increased exposure to the sun.

Introduction

Vitamin D is essential for maintaining calcium levels, healthy bones, and various other functions including immune system and glucose metabolism regulation and neuromuscular activities. Over a billion people are identified as vitamin D deficient (1). This is a pandemic for Deficiency in vitamin D. Adolescents are a particularly vulnerable population for vitamin D deficiency because of dietary and lifestyle factors which lower vitamin D levels, as well as an increase in vitamin D demand in bone growth (2,3). Even with plentiful sunlight, vitamin D deficiency is still prevalent in

populations in cultural regions of the Middle East and North Africa as a result of limited food intake, cultural practices, and limited sun exposure (4,5). Libya, specifically, lacks local documentation on the vitamin D status of adolescents.

The present study is designed aimed at determining the anthropometric and biochemical status of adolescents in Almarj, Libya, with particular focus on vitamin D, hemoglobin, ferritin and BMI. The study also aims to analyze the association of vitamin D deficiency with demographic, lifestyle factors, and the presence of anemia. This work will support the development of



evidence-based public health nutrition in Libya, and help the an evidence to build effective public health interventions.

Materials and Methods

Study Design and Participants: The descriptive cross-sectional study involved 140 school-aged students, 12–18 years old, in Almarj, Libya, and ethical approval was granted by the Faculty of Medicine, Benghazi University, with informed consent obtained from the students and their guardians.

Data Collection: Weight and height used to measure and calculate the body mass index (BMI) as kg/m^2 , World Health Organization adolescent growth reference (6) was used. Venous blood was drawn after 12 hours fasting. The serum 25(OH) vitamin D levels were determined by ELISA, automated hematology analyzer was used to measure hemoglobin, and ferritin by immunoassay.

Definitions: The different levels were used to measure and define vitamin D deficiency as $<20 \text{ ng}/\text{mL}$, insufficiency $20\text{--}29 \text{ ng}/\text{mL}$, and sufficiency $\geq 30 \text{ ng}/\text{mL}$ (7). Anemia was defined as $\text{Hb} < 13 \text{ g}/\text{dL}$ in males and $< 12 \text{ g}/\text{dL}$ in females (8).

Statistical Analysis: The data was analyzed using SPSS version 25. The descriptive statistics were presented as mean \pm standard deviation (SD) for the quantitative variables. Independent t-test was used to compare the means of the two groups and chi-square test was used to assess the relationship between the categorical variables. A p-value of < 0.05 was used to determine statistical significance.

Results

Vitamin D Status: The average serum vitamin D level of the participants was $21.65 \pm 7.54 \text{ ng}/\text{mL}$ which reflects a considerable level of insufficiency. The males had higher means of Serum vitamin D levels ($24.26 \pm 6.98 \text{ ng}/\text{mL}$) compared to the females ($19.47 \pm 7.57 \text{ ng}/\text{mL}$; $p = 0.03$). Deficiency was classified for about 60% of the students and 25% were insufficient (in Table 1 and Figure 1).

Hematological Findings: Regarding the Hematological parameters, mean concentration of Hemoglobin (over the entire sample) was $11.86 \pm 1.86 \text{ g}/\text{dL}$. Male students had higher mean Hb levels compared to female students

12.46 ± 2.24 vs. $11.64 \pm 1.66 \text{ g}/\text{dL}$; $p = 0.02$. Although Ferritin levels were higher ($39.82 \pm 32.99 \mu\text{g}/\text{L}$) in males compared to females ($28.88 \pm 25.30 \mu\text{g}/\text{L}$), the difference was not statistically significant ($p = 0.12$) (in Table 2 and Figure 2).

Body Mass Index: Distribution of BMI showed that 47.9% of students were in the Normal range, 24.3% were Obese, and 23.6% were Overweight. The difference of sex showed that females had a higher probability of being Overweight or Obese ($p < 0.001$) (in Table 3 and Figure 3). The lack of significant difference with physical activity ($p = 0.1$) suggests that the absence of regular physical activity in the sample was a contributing factor to the result.

Anemia and Its Risk Factors: Anemia prevalence was 50%, with significant associations to poor self-perceived health ($p < 0.001$) and lack of sports activity ($p = 0.032$). Chronic disease history was not significantly associated ($p = 0.09$). The mean BMI did not differ significantly between anemic and non-anemic groups ($p = 0.73$) (Table 4).

Clinical Symptoms: Headache (52.9%), fatigue (55.7%), and tachycardia (44.3%) were significantly more frequent symptoms ($p < 0.01$) among anemic students. While pallor was more frequent, this was not a statistically significant result ($p = 0.065$) (Table 5, Figure 4).

Nutritional assessment of students in almarj

Assessment of Nutritional status of children in almarj

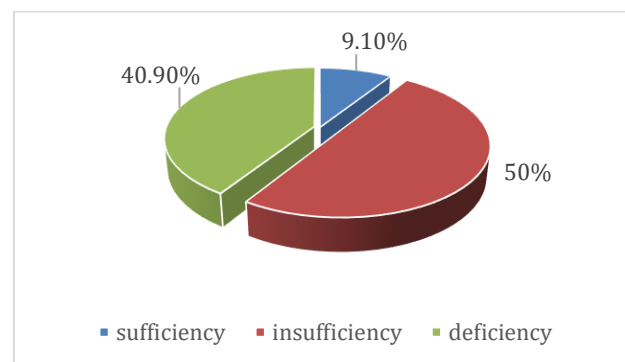


Fig (1): Distribution of students by level of vitamin D

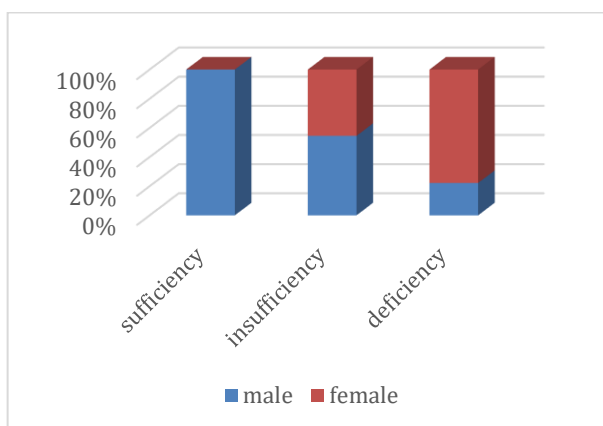


Fig (2): Distribution of students by sex and vitamin D

Table (1): Distribution of students by mean vitamin D and sex

Sex	Mean ± SD of vit D	P value
Males	24.26±6.98	0.03*
Females	19.47 ± 7.57	
All	21.65±7.54	

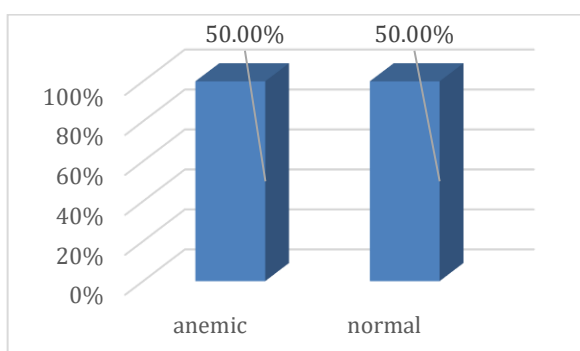


Fig (3): Distribution of respondents by anemia according to HB level.

Table (2): Distribution of students by mean HB, ferritin and sex

Sex	Mean ± SD of HB	P value
Males	12.46 ± 2.24	0.02*
Females	11.64 ± 1.66	
All	11.86 ± 1.86	
Mean ± SD of ferritin		
Males	39.82 ± 32.99	0.12

Females	28.88 ± 25.30	
All	30.8 ± 26.78	

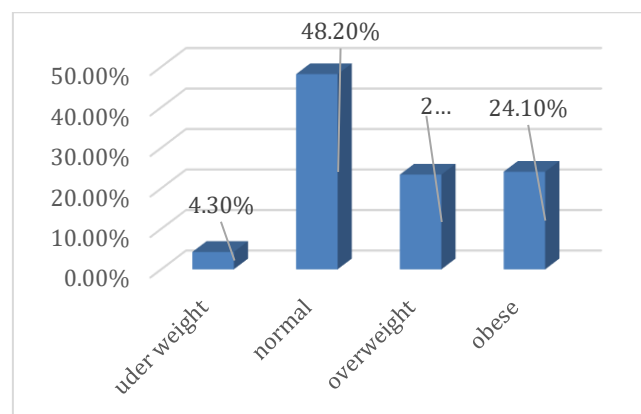


Fig (4) Distribution of respondents by body mass index

Table (3): Distribution of respondents by body mass index and determinant factors

Variables	under weight	normal	over weight	obese	Total	P value
Age						
12-	4 (66.7%)	15 (22.4%)	7 (21.2%)	9 (26.5%)	35 (25.0%)	0.1
15-18	2 (33.3%)	52 (77.6%)	26 (78.8%)	25 (73.5%)	105 (75.0%)	
Chronic disease						
No	6 (100.0%)	50 (74.6%)	27 (81.8%)	32 (94.1%)	115 (82.1%)	0.06
Yes	0 (0.0%)	17 (25.4%)	6 (18.2%)	2 (5.9%)	25 (17.9%)	
sex						
Male	5 (83.3%)	23 (34.3%)	5 (15.2%)	4 (11.8%)	37 (26.4%)	< 0.001*
Female	1 (16.7%)	44 (65.7%)	28 (84.8%)	30 (88.2%)	103 (73.6%)	
Practice of Sport						



Yes	3 (50.0%)	20 (29.9%)	7 (21.2%)	5 (14.7%)	35 (25.0%)	0.1
No	3 (50.0%)	47 (70.1%)	26 (78.8%)	29 (85.3%)	105 (75.0%)	
Total	6 (100.0%)	67 (100.0%)	33 (100.0%)	34 (100.0%)	140 (100.0%)	

Table (4): Risk factors for iron deficiency anemia .

Variables	Anemic	Normal	Total	P value
Age				
12-	17 (24.3%)	18 (25.7%)	35 (25.0%)	0.08
15-18	53 (75.7%)	52 (74.3%)	105 (75.0%)	
Chronic disease				
No	54 (77.1%)	61 (87.1%)	115 (82.1%)	.092
Yes	16 (22.9%)	9 (12.9%)	25 (17.9%)	
Mean ± SD	15.85±1.78			
BMI				
Underweight	3 (4.3%)	3 (4.3%)	6 (4.3%)	0.73
normal	34 (48.6%)	33 (47.1%)	67 (47.9%)	
overweight	14 (20.0%)	19 (27.1%)	33 (23.6%)	
obese	19 (27.1%)	15 (21.4%)	34 (24.3%)	
Perception of health				
Good	45 (64.3%)	63 (90.0%)	108 (77.1%)	< 0.001*
Not good	25 (35.7%)	7 (10.0%)	32 (22.9%)	
Practice of Sport				
Yes	23 (32.9%)	12 (17.1%)	35 (25.0%)	0.032*

No	47 (67.1%)	58 (82.9%)	105 (75.0%)	
Total	70 (100.0%)	70 (100.0%)	140 (100.0%)	

Table (5): Distribution of students by some symptoms and iron deficiency anemia.

Variables	Anemic	Normal	Total	P value
Headache				
Yes	37 (52.9%)	14 (20.0%)	51 (36.4%)	< 0.001*
No	33 (47.1%)	56 (80.0%)	89 (63.6%)	
Easy fatigability				
Yes	39 (55.7%)	17 (24.3%)	56 (40.0%)	< 0.01*
No	31 (44.3%)	53 (75.7%)	84 (60.0%)	
Tachycardia				
Yes	31 (44.3%)	12 (17.1%)	43 (30.7%)	< 0.001*
No	39 (55.7%)	58 (82.9%)	97 (69.3%)	
pallor				
Yes	26 (37.1%)	16 (22.9%)	26 (37.1%)	.065
No	44 (62.9%)	54 (77.1%)	44 (62.9%)	
Total	70 (100.0%)	70 (100.0%)	140 (100.0%)	



Discussion

This research underscores the notable occurrence of anemia and vitamin D deficiency in adolescents in Almarj, Libya, aligning with data from other parts of North Africa (9,10). The females in the study had significantly lower vitamin D and hemoglobin levels and, perhaps, due to less outdoor physical activity, conservative dress, and menstrual blood loss, which may have contributed to this. These findings are consistent with data from Saudi Arabia and Egypt, where even more stark contrasts in vitamin D levels are documented in females and males (11,12).

The imbalances in vitamin D deficiency destroy the equilibrium in the metabolism of calcium and phosphate, raising the risk of secondary hyperparathyroidism and bone loss (13). More recent studies have linked hypovitaminosis D to the newly proposed mechanisms of hepcidin and other inflammatory cytokines in the blood, thereby impacting erythropoiesis and other aspects of iron metabolism (14). Hence, the absence of vitamin D along with iron deficiency may lead to increased fatigue and other effects on immunity and cognition in adolescents.

The increasing prevalence of overweight and obesity, specifically obesity in females, is particularly troubling. Vitamin D is less available in circulation in the serum of obese individuals because the vitamin D that is stored in fat is inaccessible (15). This is due to volumetric dilution where the obese individual has more tissue and lower concentrations of the vitamin D. Sedentary lifestyles and physical inactivity significantly contribute to the obesity problem, which is worsened by the deficiency of micronutrients (16).

These findings, from the perspective of public health, require implemented school-based nutritional programs which incorporate principles of a balanced diet, promote physical activity, and ensure the children receive adequate sun exposure.

In populations where dietary diversity is restricted, the integration of fortified foods and the addition of low-dose vitamin D supplements may be effective. Anemia and vitamin D deficiency screening as components of school health programs may facilitate early intervention and help prevent the long-term complications of osteoporosis and growth retardation.

The lack of causal inference due to the use of a cross-sectional design in the study, as well as the need for further longitudinal studies relating to the season, diet, and other variables demonstrates the potential of this research. At least, in this study, potential strategic planners and health educators focusing on adolescent health and nutrition in Libya have been provided with valuable baseline information.

Conclusion

In Almarj, Libya, most adolescents suffering from deficiencies in Vitamin D and anemia are females. Certain lifestyle practices, inadequate sun exposure, and possibly dietary choices contribute to such deficiencies. Adolescents' health would greatly benefit from public health initiatives that include nutrition education, supplementation, and increased encouragement of outdoor activities.

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