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Nutritional assessment of zinc among adolescents in the Gaza Strip-Palestine*

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ABSTRACT

Zinc deficiency, obesity and stunting can be observed together in some developing countries. Moreover, zinc deficiency may enhance fat deposition and decrease lean body mass. In term of health, adequate absorbable zinc in food is essential for human health and growth. On the other hand, zinc deficiency affects children's physical growth and deteriorates health status and increases the risk and severity of a variety of infectious diseases. The aim of the study is to assess zinc nutritional status among early adolescents in the Gaza Strip-Palestine. Methods: A cross sectional study had been performed on 296 adolescents aged 12 - 15 years old. Three areas in the Gaza Strip were chosen randomly. Systematically, pupils of 7th, 8th and 9th grades were selected. Height and weight measures were taken. Questionnaires including dietary habit and physical activities of pupils were collected in addition to serum zinc level measure. Results: The overall prevalence of serum zinc deficiency among adolescents was 42.5%. Zinc deficiency was more prevalent among the females (47.7%) than the males (37.2%). The overall prevalence of high body mass index was 29%. The overall prevalence of stunting was 7.6%. The stunted males (8.8%) were more prevalent than the females (6.4%). Forty-nine percent of the females live in sedentary life style, whereas 55% of the males practiced active and very active leisure physical activity. The females were less consuming of meat, eggs and milk than the males. Serum zinc level is associated positively with consumption of meat, BMI for age, stunting and physical activities. Conclusion: Zinc deficiency is prevalent among adolescents. Serum zinc level was affected positively by consumption of animal food sources. Zinc deficiency is associated positively with the life style characteristic of adolescents in the Gaza Strip.

Keywords: Zinc; Adolescent; Physical Activity; Gaza; Palestine

1. INTRODUCTION

Micronutrients deficiency is still a serious worldwide public health problem. It is an important researchable issue for scientists and health professionals to achieve more investigations. Most of micronutrients deficiencies are sub-clinical, where this phenomenon has been called "hidden hunger" [1]. Essential vitamins and minerals, particularly vitamin A, iodine, iron and zinc are the most deficient and affect a huge number of people. Most of these people live in developing countries and are typically deficient in more than one micronutrient. Deficiencies occur when people are food insecure of such as fruits, vegetables, animal products and fortified foods, because they are too expensive to afford, or are locally unavailable [2].

Adequate absorbable zinc in food is essential for human health and growth because it has massive structural and functional roles in multiple enzyme systems that are involved in physical growth, immunological and reproductive functions. Consequently, zinc deficiency affects children's physical growth and may deteriorate health status and increase the risk and severity of a variety of infectious diseases [3].

Adolescents are considered as important for the first growth stage in the life cycle. For many adolescents, inadequate quality and quantity of food are main determinants of malnutrition [4]. Eating diverse and sufficient healthy food during adolescence is critical to compensate

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the deficits occurred during childhood and should include nutrients required to meet the demands of physical and cognitive growth and development [5].

Zinc deficiency, obesity and stunting can be observed together in some developing countries. Moreover, zinc deficiency may enhance fat deposition and decrease lean body mass [6].

Many studies concluded that reduction in the activity of carbonic anhydrase enzyme as a result of zinc deficiency among adolescents has a significant reduction and decreasing in muscle strength and work capacity [7- 9]. Low zinc intakes and low zinc in serum have been associated with impaired muscle function, including reduced strength and lead to more fatigue. Thus, low zinc status may lead to reduced physical function and performance [9].

The current critical and miserable situation in the Gaza Strip as a result of the chronic instability of internal and external political situation leads to dramatic decline in health and nutrition services which finally lead to arouse serious problems in nutrition among the most vulnerable groups including adolescents. This study aimed to assess the nutritional assessment of zinc among adolescents aged 12 - 15 years in the Gaza Strip.

2. METHODS

A descriptive and analytical cross sectional study had been carried out on 296 adolescents of both sexes in United Nation Refugee Work Agency (UNRWA) preparatory schools aged 12 - 15 years old. The present study had been carried out in the Gaza Strip. The total enrolled pupils in (UNRWA) schools of grades 7th, 8th and 9th are about 63,400 pupils.

2.1. Sample Size

The sample size was calculated according to Epidemiology Information software package (Epi Info™, last version 3.5.1, 2008) based on: a desirable confidence limit of 95%; an estimated prevalence of zinc deficiency of 30% among neighbouring countries [10]. The calculated sample was 287 subjects.

2.2. Data Collection

The data were collected in March 2009. Two UNRWA preparatory schools, one for males and the other for females, were nominated purposively in each governorate by the area general director of UNRWA. All selected schools have been obtained a daily meal for each student for a year. One class of grades 7th, 8th and 9th in each school pupils were selected randomly. About 18 students were selected systematically from the students' name list. The respondents were collected in a lab room in their school. The aim of the study was explained to all assembled respondents. Oral and written approval letter from pupils and their parents had obtained preliminary. Pupils were given a questionnaire including socio-demographic and economic questions to be answered by parents.

2.3. Food Frequency Questionnaire (FFQ)

FFQs were filled face to face with the respondents by the researcher and two assistants. It included information on the on food frequency, physical activity and life style pattern. Adapted food frequency questionnaire (FFQ) was used accordingly to suit the dietary habits among early adolescents' pupils in the Gaza Strip. FFQ measures the frequency of usual eating food item during last three months. The responses were categorized into 1) three times or more weekly, 2) less than three times weekly and 3) rarely/never. The physical activity was classified into 1) Sedentary 2) Low active 3) Active 4) Very active [11].

2.4. Anthropometric Measures

The pupils were asked to take off their shoes and any heavy clothes and stood vertically. Weight was recorded to the nearest 0.1 kg using an electronic personal weighing scale (Model: Seca 881 U. gmbh & Co.kg). Height was recorded to the nearest 0.5 cm using a special height scale developed for this purpose by World Health Organization (WHO) and UNRWA in the Gaza Strip. BMI was calculated as weight (kg) divided by height (m²) square. The cut-off points for anthropometric indicators; underweight is considered at BMI for age less than 5th percentile, while overweight and obese are at BMI equal or more than 85th percentile. Stunting (height for age) is at height less than 3rd percentile [12].

2.5. Blood Specimen Collection

About 4 ml of blood sample had been collected from the vein of the forearm. The blood sample was placed in a coded red caped vacutainer collecting tubes (Improvacuter®, no additives) for serum zinc analysis, which were directly kept in a cold keeping container (2˚C to 8˚C). After 2 hours the vacutainer tubes were centrifuged at 3000 rpm for 10 minutes. One ml serum was separated and collected in a coded polyethylene plastic tubes which in turn stored at −18˚C until determination of serum zinc level.

2.6. Bio-Chemical Analysis

Serum zinc analysis was performed in Palestinian Medical Relief Society laboratories in the Gaza Strip. Measurement of serum zinc is based on colorimetric method by using computerized chemical chemistry auto analyser

equipment (Mindray BS-200) and specified colorimetric determination kit (Global diagnostic) of serum zinc. Standard 200 µg/dl was treated as a sample for zinc. According to WHO, United Nation Children Fund's (UNICEF) and international zinc consultant group the lower cut-off values for serum zinc concentrations were 70 µg/dl and 66 µg/dl for males and females aged 10 - 15 years, respectively [13].

2.7. Statistical Analysis

The data was analyzed using Statistical package for social sciences (SPSS version 13). Serum zinc was tabulated with dietary habits, BMI and physical activity. Frequency and description of the population of the study were used to describe the serum zinc and anthropometric measures.

3. RESULTS

3.1. Characteristics of the Samples

A total of 335 adolescents (males and females) aged 12 - 15 years old were invited to participate in the present study, of those early adolescents pupils, 296 respondents only completed the FFQ, anthropometric measures and physical activity pattern aspects of the data collection process (88.4% response rate). However, 174 of the pupils set for blood sampling.

Table 1 shows the general description of the sample. The mean age of the sample was 13.7 (±SD = 0.9) years old. Moreover, the means of height and weight were 155.5 cm (±8.2 SD) and 47.5 kg (±10.6 SD), whereas the mean of BMI was 19.6 kg/m² (±3.4 SD). The average of serum zinc level was 70.1 (±14.3 SD).

3.2. Serum Zinc Level and Anthropometric Measures

In **Table 2**, it was also found that about 65.2% of the pupils were characterized by high body mass had low serum zinc level and 41.7% of them were underweighted had also low serum zinc level. Moreover, two third percent of the stunted respondents had low serum zinc level.

3.3. Serum Zinc Level and Physical Activity Pattern

Table 3 shows that physical activity pattern proportionate directly with serum zinc level. The pupil who practiced low physical activity life style had lower serum zinc level. About 59.4% of pupils who lived sedentary life style had low serum zinc level, whereas only 3.7% of pupils who practiced very active life style had low serum zinc level. It was observed that there was a statistical significant relationship between physical activity pattern and serum zinc level ($P < 0.05$).

3.4. Serum Zinc Level and Consumption of Animal Products

Table 4 shows that food frequency of milk consumption was proportional directly with the percentage of pupils who had normal serum zinc level. More frequent drinking of milk accompanied with fewer pupils had low serum zinc. Respondents who drank milk three times and more weekly characterized with normal serum zinc level. The majority (90%) of pupils who drank milk rarely or never has low serum zinc level. Similarity, those who ate egg three times or more weekly have normal serum zinc level than those who ate rarely or never. More than one half (55.6%) of the group who ate eggs rarely was characterized with low serum zinc level.

About 72% of pupils who consumed meat and its products rarely or never had low zinc level. The percentage of pupils who had low serum zinc level increases when the eating frequency of chicken, fish and liver decrease. There were statistically significant relationships between serum zinc level and consumption of milk, meat and liver, whereas no any statistical significant differences were observed between zinc and each of egg, chicken and fish.

4. DISCUSSION

This cross sectional study is the first to evaluate the nutritional status of essential micronutrient; zinc and its relationships to dietary habit, anthropometric measures and physical activity among adolescents aged 12 - 15

Table 1. General description of the sample.

Variable	Males		Females		Total	
	No	Mean (SD)	No	Mean (SD)	No	Mean (SD)
Age (yrs)	136	13.7 (0.8)	140	13.7 (0.9)	276	13.7 (0.9)
Weight (kg)	146	47.1 (11)	150	47.8 (10.0)	296	47.5 (10.6)
Height (cm)	146	156.8 (9.5)	150	154.3 (6.5)	296	155.5 (8.2)
BMI	146	19.1 (3.2)	150	20.1 (3.4)	296	19.6 (3.4)
Serum Zn level (µg/dl)	86	71.7 (15.9)	88	68.4 (12.4)	174	70.1 (14.3)

Table 2. Relationship between serum zinc level and anthropometric indicators.

Variables	Total	Serum zinc level		P-value
	N = 174	Low %	Normal %	
BMI for age				
Thinness	12	41.7	58.3	<0.05
Normal	116	33.6	66.4	
High body mass	46	65.2	34.8	
Height for Age				
Stunted	18	66.7	33.3	<0.05
Non-stunted	156	39.7	60.3	

Table 3. Relationship between serum zinc level and physical activity pattern.

Variables	Total	Serum zinc level		P-value
	N = 174	Low %	Normal %	
Physical Activity				
Sedentary	69	59.4	40.6	<0.05
Low active	45	51.1	48.9	
Active	33	27.3	72.7	
Very active	27	3.70	96.3	
Total	174	74	100	

years old in the Gaza Strip. Few researchers correlated the nutritional status with physical activities among the same age in occupied Palestinian territories [14-16]. The aim of the current study differed from the other studies as the nutritional status of zinc was highlighted and correlated to dietary habit, anthropometric measures and physical activity.

4.1. Serum Zinc Status

In this study, high prevalence of zinc deficiency was observed among the population of the study. The overall prevalence reached to 42.5%. Females had lower serum zinc level and were more prevalent than males. This may due to the fact that the females practice less frequent consumption of animal products, which are the main absorbable source for zinc. Moreover, it was found that more than 40% of the early adolescents pupils who rarely ate meat and its products rarely and more than two third of them who ate legume three times a week had low serum zinc level. The reason is that the animal products are expensive, the high percentage of poverty and food insecurity in the Gaza Strip indicated in the report of Food Agriculture Organization (FAO) and World Food Programme (WFP) [17]. These findings were higher than the estimated global prevalence of zinc deficiency, which was 31% and in the range of North Africa and the Eastern Mediterranean region, which was 25% - 52% [18].

Table 4. Serum zinc levels and consumption of animal products.

FFQ variables	**Total**	**Serum zinc level**		**P-value**
	N = 174	**Low %**	**Normal %**	
Milk and its products				
≥3 times/week	149	38.9	61.1	**<0.05**
<3 times/week	15	53.7	46.3	
Never/rarely	10	90.0	10.0	
Egg				
≥3 times/week	100	31.0	59.0	**>0.05**
<3 times/week	38	34.2	65.8	
Never/rarely	36	55.6	44.4	
Meat and its products				
≥3 times/week	94	29.8	70.2	**<0.05**
<3 times/week	44	45.5	54.5	
Never/rarely	36	72.2	27.8	
Chicken products				
≥3 times/week	28	39.3	60.7	**>0.05**
<3 times/week	114	42.1	57.9	
Never/rarely	32	46.9	53.1	
Fish products				
≥3 times/week	42	32.9	67.1	**>0.05**
<3 times/week	59	33.9	66.1	
Never/rarely	73	49.3	50.7	
Liver				
≥3 times/week	23	30.4	69.6	**<0.05**
<3 times/week	42	36.2	63.8	
Never/rarely	109	51.4	48.6	

There is a lack of studies to illustrate the prevalence of zinc deficiency among adolescents in the regional area. This study showed that the prevalence of zinc deficiency was higher than findings from Iranian and Turkish studies [19,20], but it was lower than findings in Sri Lanka [21].

4.2. Zinc and Anthropometrics

The findings revealed that there were significant relationships between zinc and both of the anthropometric measures and physical activity. Adolescents whose BMI is high have lower serum zinc level than whose BMI is normal and low. These results were in consistence with that zinc deficiency may enhance fat deposition and decrease lean body mass [6].

In this study the stunted adolescents have a risk of zinc deficiency more than non-stunted. These results were in consistence with other studies in Turkey, Sri-Lanka and

Thailand [19,21,22]. The results also indicated that the stunted adolescents were more likely consume less of animal protein than non-stunted. This confirmed that the females who consumed less animal protein have low serum level of zinc and higher percentage of stunting than males.

4.3. Zinc and Physical Activity

Higher percentage of sedentary life style was found among the female adolescents and the most active were the males. Nevertheless, it was found that adolescents with low serum zinc level are most likely practice sedentary and low active physical activity. These results showed that low serum zinc level has significant role in muscle function, including reduced strength and increased propensity to fatigue. Thus, low zinc status may lead to reduced physical function and performance [6]. It was shown in a study that zinc has important role in formation of specific enzyme, which has a role in physical activity, and shortage in this enzyme may lead to decrease in muscle strength and work capacity [9].

5. CONCLUSION

Zinc deficiency is considered a public health problem among adolescents in the Gaza strip. Serum zinc level is closely related to dietary habits, which are mostly influenced by knowledge of adolescents regarding health-eating pattern. A relationship was observed between serum zinc level and each of BMI, eating frequency of meat, and physical activity.

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