Original Article

Manifestations of nutrients deficiencies among adolescent females – case from secondary schools, Dammam, Saudi Arabia

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Abstract

This study aimed to assess the prevalence of nutrient deficiencies among Saudi female adolescents. This cross-sectional study was carried out on 225 Saudi adolescent females aged 15 to 18 years, and the subjects were recruited from secondary schools at Dammam. Data about food habits was collected, and the 24-hour recall method was used for determining nutrient intakes. The weight and height of the subjects were assessed, and BMI was calculated. The results showed that 58.2% of females had normal body weight, 20.4% were overweight, and 13.3% had obesity. Unfortunately, all participants consumed fast foods; and most of them consumed them at least once a week (48.7%). Moreover, carbonated beverages were mostly consumed by female adolescents. There was a serious deficiency in the intakes of fiber, niacin, calcium, thiamin and vitamin A, as less than 20.0% of total subjects satisfied only 50% or more of their requirements. In addition, only 7.3% of females satisfied 75.0% to 100.0% of their carbohydrate requirements, and the rest of the subjects' intake was less than that 75%. In conclusion, more than two-thirds of adolescents had a serious deficiency in the intake of vitamin A, fiber, calcium, niacin and thiamin.

1. Introduction:

ADOLESCENCE is a crucial phase of development and growth and is a critical transition period from childhood to adulthood. Universally, adolescent girls are about one-fifth of the total female population [1]. The phenomenal development in adolescence creates improved demands for nutrients and energy. Physical growth and nutrition are inherently associated; similarly, optimal nutrition is obligatory for gaining full growth [2]. The nutrients intakes are directly associated with the growth, maintenance, reproduction, and disease or health condition of an individual [1,3,4]. Nutrition is an important constituent of the entire healthcare sector among adolescents [4,5,6]. Female adolescents have relatively higher iron requirements due to menstrual losses, sexual maturation, and growth spurts [5]. The iron stores are

exhausted in female adolescents with the onset of menstruation, and they are particularly at higher risk of developing iron deficiency [6]. Studies have indicated that the prevalence of nutrient deficiency has increased in Arab countries [7,8,9,10].

Eating habits among adolescents may transform from regular to irregular meals. Adolescents have been observed at the highest prevalence rate of inadequate nutrients among different age groups [11,12]. Consuming fast food may also cause chronic illness, nutrient deficiencies, obesity, and overweight [7,8,12,13].

Increasing economic transformations in Saudi Arabia, globalization, urbanization, and social and technological modifications have resulted in inadequate intake of essential nutrients [4,14]. It refers to the transformation of traditional diet patterns to western diet patterns, which brings changes in different lifestyle factors and physical activities. Living standards are rising, which leads to complex alterations in diet and health patterns [15,16].

To the best of our knowledge, few published studies were conducted to assess the nutrient deficiencies among female adolescents aged between 15 to 18 years in Saudi Arabia, but no research was conducted to assess the nutrient intakes of adolescents' females in Dammam Eastern Province. Therefore, this study has mainly focused on a better understanding of nutrient deficiencies among this important and vulnerable population group and on helping adolescent females get adequate amounts of essential nutrients to maintain good health status. The major objective of this study was to evaluate the nutrient intakes and the manifestations of nutrient deficiencies among Saudi female adolescents in Dammam.

2. Subjects and Methods

2.1 Subjects

A random sampling approach has been applied, through which the secondary schools of female adolescents in Dammam, Eastern Province, Saudi Arabia, have been targeted. The sample size of participants required for the study was calculated according to the formula given by Charan and Biswas, 2013 [17]:

$$\text{Sample size} = \frac{= Z_{1-\alpha/2}^{2} \times P(1-P)}{d^{2}}$$

Where: $Z_{1-a/2}$ = Is standard normal variate (at 5% type 1 error ($P<0.05$) it is 1.96)
P = Expected proportion in population
d = Absolute error or precision

$$\text{Sample size} = \frac{1.96^{2} \times 0.17 (1-0.17)}{0.05^{2}} = 217$$

To overcome participants' withdrawn and incomplete questionnaires and missing data, the researchers randomly recruited two hundred forty-five females aged between 15 to 18 years.

However, 20 females were excluded because of withdrawal, chronic illness, and refused to participate. The sample was collected by a multi-stage random sampling technique; initially, three schools were chosen randomly from a list of Dammam schools. A list of classes was developed for each targeted grade (grades one through three) in the chosen schools. All classes from each grade level were chosen (27 classes). The average class size was roughly 25, which meant that around 675 female students were eligible. According to inclusion and exclusion criteria, a random sample of 225 females was eligible, agreed to participate, and completed the study.

Recruiting females to participate in medical and health research is difficult to some extent in Saudi Arabia due to some gender restrictions; therefore, the present study has recruited only female participants from secondary schools in Dammam. The study has effectively contributed to recruiting a large sample size to assess females' nutrient deficiencies. The recruitment of females from different schools may enable the study to contribute to medical and health research.

2.2 Methods

2.2.1 Socioeconomic and health data

Data regarding age, marital status, parents' educational level, family size, and monthly income was collected using a validated questionnaire by the trained interviewer. The inclusion and exclusion of subjects depended upon the disease history and use of any medicine for chronic illness.

2.2.2 Anthropometric and biochemical parameters

Bodyweight and height were measured using a stadiometer scale nearest 0.1 kg for weight and nearest 0.5 cm for height. A non-stretchable measuring tape was used to estimate waist circumference (WC). Hip circumference was measured at the point, yielding the maximum circumference over the buttocks. The bodyweight of the females was taken through a weighing scale, which was set accurately to zero kg when measuring weight (kg). The measures of body height and weight were used to calculate the BMI of female adolescents. Using standard classification of BMI given by WHO for age 5-19 years [18], the participants were classified into (1) severe thinness: <-3SD, (2) thinness: <-2SD, (3) healthy -2SD to +1SD, (4) overweight: >+1SD, and (5) obesity: >+2SD.

2.2.3 Food Habits and nutrients intakes

Data about common food habits was collected from each respondent. The method used to assess food habits or consumption patterns was direct questions about diet history (i.e., meal number, skipped meals, fast foods, and carbonated beverages). Nutrients intakes were determined by 24 hr. food recall, in which the respondents were asked to recall the food and drink items that were consumed in the last 24 hours (obtained for 3 different days, including one holiday). Consumed food was analyzed by food composition tables of the Arab Gulf countries (Saudi Foods), and the results were compared with standard dietary requirements [19].

2.2.4 Standard dietary requirements

The daily energy needs (kcal/kg/day) of the participants were determined using the formula provided by the Institute of Medicine [19]. Minerals and vitamins requirements were determined using the adequate intakes (AI) indicated in DRI guidelines.

2.2.5 Data Analysis

The collected data were statistically analyzed using Statistical Package of Social Sciences (SPSS) ver. 23, and the outcomes have been presented in tabular form as frequency and percentage or mean ± SD. The study has targeted to evaluate the deficiencies and the reasons behind the nutrient deficiencies among the adolescents, which could easily be observed through descriptive statistics. The

significant differences for numerical variables were calculated by one sample t-test. Also skewness and kurtosis of data were calculated.

2.2.6 Ethics

An agreement was signed by all participants, outlining the purpose and procedures of the study and the names of those who had signed the document, the date, and their commitment. All of the participants in the study have signed it. University Institutional Review Board (IRB) Committee and the Ministry of National Guard, Health Affairs in Eastern Province, Kingdom of Saudi Arabia (KSA) have approved this research. (IRB UGS 2015-03-214).

3. Results

The majority of the participants were 17 years (36.0%) and 16 years old (32.4%) (Table 1). About one-third of the mothers were working, whereas more than half of the mothers were housewives (53.5%). The education level of the mothers and fathers of the majority of respondents was college (40.9% and 40.4%, respectively) and secondary school (33.8 percent and 35.6 percent, respectively). The monthly income for 46.2% of the subject families was more than 15,000 SR/month. Also, most of the subjects (61.3%) had a family size of approximately 6-8 persons (Table 1).

Table 1. General characteristics of subjects

Variable	Response	no	%	Variable	Response	no	%
Age (years)	15	24	10.7	Family Size	With relatives	16	7.1
	16	73	32.4		Less than 6	29	12.9
	17	81	36.0		6 to 8	138	61.3
	18	47	20.9		More than 8	42	18.7
	Total	225	100		Total	225	100.0
Education Level of Father	Illiterate	0	0	Education Level of Mother	Illiterate	3	1.3
	Primary	7	3.1		Primary	13	5.8
	Alimentary	16	7.1		Alimentary	23	10.2
	Secondary	80	35.6		Secondary	76	33.8
	Diploma	11	4.9		Diploma	10	4.4
	University	91	40.4		University	92	40.9
	Postgraduate	20	8.9		Postgraduate	8	3.6
	Total	225	100.0		Total	225	100.0
Family Income (SR/month)	Unknown	14	6.2				
	< 5000	6	2.7				
	5000 to 10000	24	10.7				
	10000 to 15000	77	34.2				
	> 15000	104	46.2				
	Total	225	100.0				

As shown in Table 2, 42.2% of adolescents consumed three meals; more than one-third consumed two meals, and 7.6% consumed one meal daily. The most skipped meals were supper (39.1%) and breakfast (29.8%). Moreover, only 35.6%

consumed breakfast regularly, and 89.8% of females in this study ate snacks (originally potatoes, chips, biscuits, and chocolate bars). Surprisingly, 100.0% of the studied adolescent females consumed fast foods; and most of them consumed them once (48.4%) and twice a week (26.7%). About 81.8% of adolescents consumed carbonated beverages. Most adolescent females consumed 1 to 2 cans per day (42.7%), and the preferred amount was 250 ml/time (50.2%). A considerable percentage (28.0%) of adolescents consumed Arabic coffee only, while 18.2% consumed Nescafe, and 14.2% consumed Nescafe and Arabic coffee.

Table 2. Common food habits among subjects

Food Habit	Response	no	%	Food Habit	Response	no	%
Daily meals	One meal	17	7.6	Skipped meal	None	22	9.8
	Two meals	81	36.0		Breakfast	67	29.8
	Three meals	95	42.2		Lunch	26	11.6
	More than 3	32	14.2		Supper	88	39.1
					Breakfast, supper	22	9.8
	Total	225	100.0		Total	225	100.0
Eat breakfast regularly	No	50	22.2	Eat snacks	No	23	10.2
	Sometimes	95	42.2		Sometimes	0	0.0
	Yes	80	35.6		Yes	202	89.8
	Total	225	100.0		Total	225	100.0
Eat fast foods	No	0	0.0	Frequency of fast foods (time/week)	Rare	8	3.6
	Sometimes	101	44.8		Once	109	48.4
	Yes	124	55.1		Twice	60	26.7
					Three	35	15.6
					More than 3	13	5.8
	Total	225	100.0		Total	225	100.0
Consumption of carbonated beverages (cans/day)	None	36	16.0	Amounts of carbonated beverages (ml/time)	None	36	16.0
	Less than 1	40	17.8		Less than 250 ml	9	4.0
	1 to 2 cans	96	42.7		250 ml	113	50.2
	More than 3 cans	53	23.5		More than 250 ml	67	29.8
	Total	225	100.0		Total	225	100.0
Drink Coffee	None	46	20.4				
	Turkish	7	3.1				
	Arabic	63	28.0				
	Nescafe	41	18.2				
	Nescafe, Arabic	32	14.2				
	All kind	36	16.0				
	Total	225	100.0				

Table 3 showed the anthropometric indices of studied females, and it could be noticed from statistical analysis (i.e., skewness and kurtosis) that age, body height, and waist to hip ratio were normally distributed, while for body weight and **BMI**, the data were skewed to the right side which in turn indicated the tendency towards normal body weight among studied adolescent females. According to the

categorization of BMI values shown in Table 4, about 58.2% of adolescents girls in this research had healthy body weight, 20.4% were overweight, and 13.3% were obese. Interestingly, 8.0% of the population suffered from thinness.

Table 3. Mean ± SD of age and anthropometric measurements

	Mean±SD	Skewness	Kurtosis	One sample t-test	
				Value	Sig.
Age (year)	16.7±0.9	-0.12	-0.85	270.3	0.000***
Body weight (kg)	57.4±11.7	0.85	0.13	73.70	0.000***
Body height (cm)	156.9±5.2	0.21	-0.45	455.0	0.000***
BMI (kg/m2)	23.3±4.5	0.92	0.24	77.60	0.000***
Waist circumference (cm)	75.2±9.4	0.72	0.11	119.6	0.000***
Hip circumference (cm)	94.3±10.3	0.69	0.30	136.7	0.000***
Waist to Hip ratio	0.8±0.05	0.14	-0.16	227.8	0.000***

*SD: standard deviation; *** Significant at P<0.001.*

Table 4. Classification of females subjects according to BMI classification*

BMI classification	Frequency	Percentage
Thinness	18	8.0
Healthy weight	131	58.2
Overweight	46	20.4
Obese	30	13.3
Total	225	100.0

* obtained from WHO, (2017) [18]

Table 5 demonstrates that Saudi female adolescents were severely deficient in fiber, niacin, and vitamin A, with just 30% of overall recommended dietary needs satisfied. Their calcium, thiamin, and carbohydrate intakes were less than half of the recommended range. Intake of vitamin C, calories, and phosphorus were all below the recommended limits. The skewness and kurtosis testing revealed that the calories, total fat, total protein, and riboflavin intakes were properly distributed. Carbohydrates, animal fats, proteins, vitamin A, niacin, total iron, phosphorus, and calcium consumption were skewed to the right. This shows an overall downward trend in nutrient intake. While there was no discernible trend in vitamin C consumption, the researchers could not draw any inferences from this.

Results shown in Table 5 did not provide a clear picture of the prevalence of deficiency; therefore, an attempt was made to present a precise figure about the percentage of nutrients intakes. As shown in Table 6, the subjects were distributed according to the percentage of nutrients intakes to standard requirements. All the studied subjects did not cover 50% of their standard fiber requirements. It was clear that most adolescent females in this study failed to satisfy 50% of their standard requirements.

There was an evident deficiency in intake from vitamin A (88.0%), calcium (83.6%), niacin (82.7%), thiamin (78.2%), vitamin C (67.1%), and carbs (61.8%). The majority of subjects covered 50 to 75% of their requirements from calories (44.0%). However, the results emphasized that more than 50.0% of females covered more than 100.0% of their requirements from total protein and riboflavin.

Table 5. Mean Intakes from Essential Nutrients As Compared With Standard Values

Nutrient	Mean±SD	%Std	Skewness	Kurtosis	One sample t-test	
					Value	Sig.
Energy (Kcal/day)	1245.8±349.0	64.8%	0.51	-0.01	47.4	0.000***
Carbohydrate (g/day)	144.9±50.1	48.2%	0.69	-0.02	43.4	0.000***
Fiber (g/day)	5.2±2.7	20.2%	0.65	-0.41	28.8	0.000***
Animal fat (g/day)	28.3±14.1		0.75	0.17	30.0	0.000***
Total Fat (g/day)	46.7±18.5	87.5%	0.84	0.90	37.8	0.000***
Animal protein (g/day)	46.8±25.8		0.15	-0.94	27.3	0.000***
Total protein (g/day)	61.4±26.8	105.2%	0.15	-0.78	34.3	0.000***
Vitamin C (mg/day)	31.6±20.7	50.0%	0.87	-1.02	11.7	0.000***
Niacin (mg/day)	3.2±1.5	23.3%	1.27	0.50	14.0	0.000***
Riboflavin (mg/day)	1.3±0.9	133.0%	1.24	1.06	20.2	0.000***
Thiamin (mg/day)	0.4±0.2	39.5%	1.16	1.46	23.8	0.000***
Vitamin A (mcg/day)	203.9±127.7	29.3%	0.77	0.25	23.9	0.000***
Animal iron (mg/day)	2.2±1.0		0.60	-0.11	20.2	0.000***
Total iron (mg/day)	14.4±8.4	96.0%	0.47	-1.09	25.6	0.000***
Phosphorus (mg/day)	829.7±348.4	66.4%	0.30	-0.72	35.5	0.000***
Calcium (mg/day)	423.8±229.7	32.9%	0.85	0.45	27.7	0.000***

*SD: standard deviation; *** Significant at P<0.001.*
%Std: calculated by dividing total intake by standard requirements and the net multiplied by 100.

Table 6. Distribution of Adolescents' Girls According to Percentage of Nutrients Intakes

Nutrient	Percentage of Nutrients intakes*			
	< 50.0%	50.0% to <75.0%	75.0% < 100.0%	> 100.0%
Energy	62 (27.6%)	99 (44.0%)	51 (22.7%)	13 (5.8%)
Carbohydrate	139 (61.8%)	69 (30.7%)	17 (7.6%)	0 (0.0%)
Fiber	225 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total Fat	25 (11.1%)	65 (28.9%)	74 (32.9%)	61 (27.1%)
Total Protein	34 (15.1%)	35 (15.6%)	37 (16.4%)	119 (52.9%)
Vitamin C	151 (67.1%)	3 (1.3%)	3 (1.3%)	68 (30.2%)
Niacin	186 (82.7%)	21 (9.3%)	18 (8.0%)	0 (0.0%)
Riboflavin	48 (21.3%)	38 (16.9%)	23 (10.2%)	116 (51.6%)
Thiamin	176 (78.2%)	30 (13.3%)	11 (4.9%)	8 (3.6%)
Vitamin A	198 (88.0%)	19 (8.4%)	8 (3.6%)	0 (0.0%)
Total Iron	52 (23.1%)	59 (26.2%)	27 (12.0%)	87 (38.7%)
Phosphorous	74 (32.9%)	69 (30.7%)	53 (23.6%)	29 (12.9%)
Calcium	188 (83.6%)	27 (12.0%)	10 (4.4%)	0 (0.0%)

* Calculated by dividing the percentage of intakes into four categories (1) < 50.0%, (2) 50.0% to <75.0%, (3) 75.0% < 100.0%, and (4) > 100.0% of standard requirements

4. Discussion:

The results have shown that the female adolescents usually consume three meals a day, but most were observed to skip breakfast in the morning. As per the results, breakfast was less frequently consumed by the females, whereas the intake of

snacks was observed to be relatively greater. Nutrients of vegetables, meat, and fruits were less consumed when fast food intake was greater. Carbonated beverages were mostly preferred, which can also be the main reason for nutrient deficiency among females at the secondary school level. The significant dietary problem among adolescent females is consuming a high amounts of fats (i.e. saturated fat), and sodium and a low amounts of fiber, fruits, and vegetables. Although females gained excess weight, it cannot be termed as healthy due to low levels of basic nutrients like calcium and iron-rich food in their diet. The ability to gain recommended nutrient intake is a quality diet, which must be taken within the recommended energy intake amount [20,21,22]. The major nutrient deficiencies prevailing in Arab countries include iodine, vitamin A, vitamin D, and iron [4].

This study has precisely explained the long-standing public health problem in the Arab region: nutrient deficiencies. According to the results, it has been evaluated that consumption of fast food, junk food, and sweetened beverages is popular among almost all adolescents. The average body weight of female adolescents between the ages of 15 to 18 was 58.4 kg, possibly due to the fast food and excess consumption of carbonated beverages. The results depicted that intakes of fiber, vitamin A, niacin, calcium, carbohydrate, and thiamin were scarce in the diet of Saudi adolescent females. Moreover, 20% were suffering from overweight, and 15.2% had obese. More than half of the females could not meet their daily requirement of nutrients. It was emphasized that most of them suffered from a serious deficiency of 7 essential nutrients (iron, carbohydrates, vitamin C, niacin, vitamin A, calcium, and fiber). The intakes of minerals, vitamins, and trace elements were the most important dietary components that mostly fell below the requirement. It is also believed that parents' educational level and financial status play a major role in the nutritional status of adolescent girls; the higher the socioeconomic status, the better the nutritional status of adolescent females will be.

Vitamins are essential for the human body, and the daily requirement for vitamin-rich food intake has been established and recommended by the national and international authorities [23,24]. A lack of vitamins impairs certain metabolic processes, stunting growth and disease. It is required to have a certain intervention of nutrition, knowledge, and healthcare-associated behaviors among female adolescents to reduce the risk of obesity [25,26]. Adolescence with the commencement of the second period of growth acceleration follows when the hormonal influences are involved. There are also some transformations, including the development of fat, long bones, sex characteristics, and muscle mass. As a person enters their adolescent years, their dietary habits begin to deteriorate. An unhealthy diet during this period can negatively affect development and growth and is less probable to persist into maturity [18]. It is emphasized that there is a need for future studies to focus on the food habits of adolescent girls to evaluate how dietary habits affect the health status of the female population. In the concerned region, iron deficiency is regarded as the most common problem among adolescents, and its prevalence ranges from 12.6% to 46% [27].

In a cross-sectional study conducted in Kuwait, it was determined that iron deficiency was more prevalent among females as compared to males [28]. Food rich in vitamin C should be consumed as it is responsible for enhancing iron absorption. Vitamin C is mostly found in fresh vegetables and fruits, which are not widely consumed by female adolescents, leading to various body deficiencies [29].

As vitamins are active substances and essential for the human body, national and international authorities have established and identified the daily requirement for

vitamin-rich food. If vitamins are unavailable or scarce in quantity, they impair certain metabolic processes, stunting growth and disease [30].

In order to establish proper dietary habits that would persist in adult life, it is necessary to adopt a balanced diet during childhood for the proper well-being and growth of the individual [31]. According to a British Nutrition Foundation (BNF) study, the majority of adolescents had poor intakes of minerals and vitamins such as iron, calcium, magnesium, riboflavin, and vitamin A. These findings were supported by research undertaken by Deka et al. [32], which found that adolescent females eat fewer calories and blood-forming micronutrients.

5. Conclusion:

The present study has contributed to explaining long-established nutritional public health issues which prevailed in the Arab region. Almost all adolescents consume junk food, fast food, and sweetened beverages, which causes fiber, niacin, and vitamin A deficiencies. The present study outcomes suggest that female adolescents must consume an adequate and balanced diet. It has been found essential to promote healthy activities and health promotional training programs in the female secondary schools of Dammam. Females require effective intervention programs that raise their degree of health awareness. In Saudi Arabia, many initiatives should be used to encourage healthy eating habits among female adolescents. The current study looked at secondary schools and girls aged 15 to 18. In contrast, future studies could recruit primary-level children and their parents to assess their awareness of nutrient deficiencies and their reasons. High priority should be given to such studies as it might help implement adequate health and nutrition program measures to control and prevent nutrient deficiencies.

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