Impact of Dietary Patterns and Nutritional Status on the Academic Performance of Omani School Students

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Abstract: In a cross-sectional study, we determined the dietary patterns and nutritional status of Omani school students (12-15 years), and their association with student's academic performance. A study questionnaire, including a semi-quantitative food frequency questionnaire, was used to collect data. Results indicated that 36% of Omani school students regularly consumed breakfast, whereas only 21.7% had daily 3 meals. Similarly, 30.5% of students consumed fruits ≥ 2 serving/day, 26.6% consumed vegetables ≥ 3 serving/day, and 49.8% consumed fish ≥ 2 serving/week. Significant differences were observed regarding breakfast consumption among genders, regular intake of daily 3 meals, fruits, fish, avoiding soft drinks, nutritional knowledge, total energy and macronutrient intake. Based on BMI, 12.3 % of students were overweight, and 26.1% were obese. The students did not have enough nutritional knowledge and showed unhealthy dietary patterns indicated by their mediocre Omani Diet Scores. Daily energy and macronutrient intakes in males were significantly higher than females. Only fish intake, avoiding soft drinks, waist to height ratio (WHtR), and nutritional knowledge score showed significant associations with student's academic performance. Healthy dietary patterns and improved nutritional status of school students showed a positive association with their academic performance, suggesting that more focus should be placed in developing healthy dietary patterns.

Keywords: Dietary patterns, nutritional status, academic performance, Omani school students.

INTRODUCTION

Dietary patterns play a crucial role in regulating and maintaining the basic functions of growth and development as well as the immune system in children and adolescents [1]. Dietary patterns represent the amount and type of foods or mixture of foods and drinks, their frequency of intake, which are habitually consumed as a part of the daily diet. Unhealthy dietary patterns and poor nutritional status in school students can affect their health and academic performance [2]. There is an increasing pressure in schools to persistently improve their academic performance by reducing the school time for health education and physical activities, which may, however indirectly affect both student's health and their academic performance [2, 3]. Several factors, including psychological, economic, environmental, social, and personal issues, as well as the food intake patterns and nutritional status, might affect the academic performance of students [2]. The globally changing trends in food environments related to increased consumption of energy-dense fast foods and a sedentary lifestyle are associated with higher rates of overweight and obesity in school students [4]. However, unhealthy dietary and lifestyle patterns such as skipping of breakfast and regular meals, excessive intake of fast foods and soft drinks together with an inadequate intake of fruits, vegetables and fish as well as a reduced level of physical activity may have serious consequences related to obesity and poor academic performance in school students [5-9].

Breakfast is an important factor in enhancing the cognitive and academic performances by enhancing postprandial memory functions [5, 10]. Intake of fresh fruits and vegetables is linked to better mental health such as positive mood, greater happiness, socio-emotional flourishing, and overall wellbeing [11]. Higher intake of fish rich in ω-3 PUFA is linked with higher school grades [2, 7], whereas fast foods were observed to be linked with poor academic performance in children [9]. During recent years, the rate of overweight and obesity in school-aged children has increased at an alarming level in the Gulf cooperation council countries [12]. The obese children are more likely to remain obese during the adolescence and adulthood, leading to the risk of poor health [13]. Obese children were observed to repeat grades in schools, whereas obese adolescents were found to be more absent from school compared to normal weight students [14].

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The number of schools in Oman has increased from 3 schools with 900 students in 1970 to 1125 schools with 579,024 students in 2018 [15]. In order to improve the social and economic development in Oman, the Ministry of Education (MoE) is concerned about student's academic performances in schools. Very limited data is available in Oman about the dietary intake patterns and nutritional status of school students, in practice no study has been done to evaluate their impact on the academic performance of school children. The present study was, therefore conducted to evaluate the dietary patterns and nutritional status of Omani school students and their impact on their academic performance. This study will help the parents, teachers, school management, Ministry of Education as well as the public health researchers to encourage the Omani school students to understand and follow the healthy dietary patterns for their improved academic performance.

SUBJECTS AND METHODS

Study Population

It is a cross-sectional study that included 203 healthy Omani school students of both genders (104 males and 99 females) aged between 12 to15 years, from grade 8^{th} and 9^{th}. Non-Omani students were excluded from the study because of ethnic differences in dietary patterns. Any Omani student with medical illness, psychiatric disorder and/or learning disability was excluded from the study due to differences in dietary patterns and nutritional status as compared to healthy students [16]. Study participants were selected randomly from four different second cycle public schools located in Al-Seeb, Governorate in Muscat, Sultanate of Oman. The study was carried out from September 2018 to April 2019. The ethical approval of the study was obtained from the Ministry of Education (MoE), The Sultanate of Oman (Reference number: 2818220511 dated September 18, 2018). All the study participants, their schoolteachers and parents were briefed about the purpose of this study and were explained about their right to confidentiality, and their consent was obtained.

Study Tools

A validated modifiable questionnaire (survey) was given to all the participants. It contained questions related to demographic data, weight status, nutritional knowledge, Omani Diet Score, and a semi-quantitative food frequency questionnaire (FFQ). The academic performance of the students was assessed by using the grade point average (GPA) in a semester. The classification of GPA was based on the Ministry of Education (MoE) score. For anthropometric measurements, "The SECA Stadiometer" and a non-elastic tape were used to measure height and weight. The anthropometric measurements for all participants were taken by the researcher together with school nurses in the school's clinic. Different indicators were used to measure the weight status including body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR). The BMI-for-age percentiles were used to identify the weight status of school students. School students were classified overweight from 85^{th} to 97^{th} percentiles and obese at more than 97^{th} percentiles. The optimal cut-off values for WHR and WHtR were calculated according to Motlagh *et al.* [17]. A self-reporting questionnaire was explained in the classroom, and it was understood and recorded by all school students after clarifications. It was further checked and vetted by the researcher. The daily energy and macronutrient intakes of the participants were assessed in personal interviews by the researcher. The student's GPA was collected at the end of the first semester by accessing the official website of MoE "Educational Portal". The GPA used to evaluate the academic performance was based on the 6 main subjects, including Islamic Education, Social Studies, Arabic, Mathematics, Science, and English.

Omani Diet Score

Omani Diet Score is a diet quality measurement based on the Recommended Daily Allowance (RDA) and the Healthy Eating Index (HEI). It describes how diet fits within the recommendations of macro- and micro-nutrients intake. The score is based on 25 dietary assessment questions related to amount and type as well as the frequency of daily food and beverage intake patterns. The Omani Dietary Score focused on specific dietary intake patterns, including breakfast consumption, daily intake of all 3 meals, fruits and vegetable intake, fish intake, trying to reduce the fast food intake, and avoiding the soft drinks. Frequency of dietary intake patterns was defined as how many times a week does the school students eat breakfast, consume daily three meals, fruits, vegetables, fish or avoid soft drinks or try to reduce the intake of fast foods. The categories of responses were always (7 days/week), often (4-5 days/week), sometimes (1-2 days/week), and never (0 day/week). The score ranged from 0 to 100 to assess the healthy eating patterns. The higher the score, the healthier eating patterns, and lower scores indicated unhealthy eating patterns.

Food Frequency Questionnaire

A previously tested and validated semi-quantitative food frequency questionnaire (FFQ) was used for this study [18]. It was used to estimate the total daily energy and macronutrient intake. It was meant to collect the amount and frequency of dietary intake for a variety of food items that are generally eaten in Oman. There were 47 questions with various responses including yearly (Never, a few times), monthly (1-2 times), weekly (1-2 times, 3-4 times, 5-6 times), and daily (one time, 1-3 times, 4-5 times). The frequencies of food items were transformed into intake on daily basis to calculate the macronutrient intake in grams. Food intake assessment data was based on the nutrient analysis program or previously determined food composition of traditional local Omani dishes [19-22].

Statistical Analysis

The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS version 22). Calculations for BMI, WHR, and WHtR were done by using Microsoft Excel 2010. Chi-square test (χ^2) was used to compare the dietary patterns and nutritional status of male versus female Omani school students. It was also used to ascertain an association between dietary patterns and nutritional status with the student's academic performance. Moreover, unpaired Student's *t*-test was used to compare the means including age, weight, height, BMI, WC, WHR, WHtR, Omani diet score, nutritional knowledge score, total energy, protein, carbohydrate and fat intake of male versus female Omani school students. The *P*-value of < 0.05 deemed as statistically significant [23].

RESULTS

The data on the general characteristics of male and female Omani school students are shown in Table **1**. Most of the participants were between 13 to 14 years old (44.3% and 45.3%, respectively). The student's grades of 1st semester were almost evenly distributed, and only 3.9% of students got F. Various anthropometric indices showed variability in overweight and obesity rates in the study population. The overweight and obesity rates according to BMI-for-age, were 12.3% and 26.1%, respectively, whereas according to waist circumference (WC) these were 15.8% and 31.5%, respectively. According to waist-to-hip ratio (WHR), 72.4% were not at risk, whereas according to the waist-to-height ratio (WHtR), 51.2% were not at risk. The comparison of overall gender differences in the general characteristics of Omani school students (averages, $\bar{x} \pm$ SD) is shown in Table **2**. Significant ($P < 0.05$) differences were observed between male and female students with respect to semester grades, height, weight, WHR, and nutritional knowledge. The male students were significantly taller

Table 1: General Characteristics and Anthropometric Data of Study Participants

Characteristics	Frequency (n)	Percent (%)
Gender		
Male	104	51.2
Female	99	48.8
Age		
12	6	3.0
13	90	44.3
14	92	45.3
15	15	7.4
Grade of 1st semester (%)		
A	51	25.0
B	53	26.0
C	52	25.5
D	39	19.1
F	8	3.9
BMI for age[a]		
Sever thinness	18	8.9
Thinness	26	12.8
Normal	81	39.9
Overweight	25	12.3
Obesity	53	26.1
WC[b]		
Not at risk	107	52.7
Overweight	32	15.8
Obesity	64	31.5
WHR[c]		
Not at risk	147	72.4
Overweight & Obesity	56	27.6
WHtR[d]		
Not at risk	104	51.2
Overweight	35	17.2
Obesity	64	31.5

[a]BMI-for-age percentiles: Sever thinness: <3rd; Thinness: 3rd - < 15th; Normal: 15th - < 85th; Overweight: 85th - < 97th; Obesity: > 97th: [b]Waist Circumference (WC) cm: Not at risk < 72.72cm; Overweight ≥ 72.72cm; Obesity (Male ≥ 77.55cm; Female ≥ 77.70cm). [c]Waist-to-hip ratio (WHR): Not at risk (Male < 0.88, Female < 0.84); Overweight and Obesity (Male ≥ 0.88, Female ≥ 0.84). [d]Waist-to-height ratio (WHtR): Not at risk: (Male < 0.46, Female < 0.47); Overweight (Male ≥ 0.46, Female ≥ 0.47), Obesity (Male ≥ 0.47, Female ≥ 0.50).

Table 2: Comparison of Overall Gender Differences in the General Characteristics of Omani School Students (Averages, $\bar{x}$ ± SD) *

Characteristics	Male (n =104)	Female (n= 99)	*t*	df	*P*-value
Age	13.63 ± 0.70	13.51 ± 0.65	1.37	201	0.17
Grade of 1st semester (%)	72.63 ± 13.93	82.73 ± 12.57	-5.42	201	< 0.001*
Height (cm)	160.05 ± 9.65	154.26 ± 6.64	4.95	201	< 0.001*
Weight (Kg)	56.51 ± 20.54	54.60 ± 17.75	0.71	201	0.48
Body Mass Index	21.76 ± 6.72	22.77 ± 6.57	-1.08	201	0.28
WC[a] (cm)	76.09 ± 15.60	75.32 ± 15.06	0.36	201	0.72
Hip circumference (cm)	90.21 ± 15.58	92.58 ±13.08	-1.17	201	0.24
WHR[b]	0.84 ± 0.07	0.81 ± 0.07	3.28	201	< 0.001*
WHtR[c]	0.48 ± 0.09	0.49 ± 0.09	-1.03	201	0.31
Nutritional knowledge	13.51 ± 16.89	28.83 ±25.64	-5.05	201	< 0.001*
Omani Diet Score	59.45 ± 8.39	58.39 ± 7.76	0.93	201	0.35

*Data Presented as mean ± Standard Deviation ($\bar{x}$ ± SD), unpaired Student *t*-test, significantly difference, $P < 0.05$. [a]Waist circumference (cm): Not at risk < 72.72, Overweight ≥ 72.72, Obesity (Male ≥ 77.55; Female ≥ 77.70). [b] Waist-to-hip ratio: Not at risk (Male < 0.88, Female < 0.84), Overweight & Obesity (Male ≥ 0.88, Female ≥ 0.84. [c] Waist-to-height ratio (WHtR): Not at risk : (Male <0.46 , Female < 0.47), Overweight (Male ≥ 0.46 , Female ≥ 0.47), Obesity (Male ≥ 0.47 , Female ≥ 0.50).

than the female students, but no significant differences were observed in the body weight of male and female students. More female students (83%) scored significantly higher grades as compared to male students (73%). As shown in Figure **1**, the female students got more “A” (37.4%) as compared to males (13.5%), whereas the male students scored more “D” (27.9%) as compared to females (10.1%). Similarly, female students had significantly better nutritional knowledge as compared to male students.

The data on the overall dietary intake patterns of Omani school students are given in Table **3**. The results indicated that only 36% and 21.7% of school students regularly consumed breakfast and daily all 3 meals, respectively. Only 30.5% of students always consumed ≥ 2 serving/day of fruits and 26.6% consumed ≥ 3 serving/day of vegetables. Almost 50% of the students consumed ≥ 2 serving/week of fish. It is interesting to note that 23.6%, 37.9% and 23.6% of students never consumed fruits, vegetables, and fish, respectively. The data indicated that 31% of students always avoided taking soft drinks and 19.7% drank ≥1 soft drink per day. About 26.6% of the study participants always tried to reduce their fast food intake and consumed ≤ 3 servings per week. Table **4** shows the statistical analysis of the dietary intake patterns of male and female Omani school students. Significant

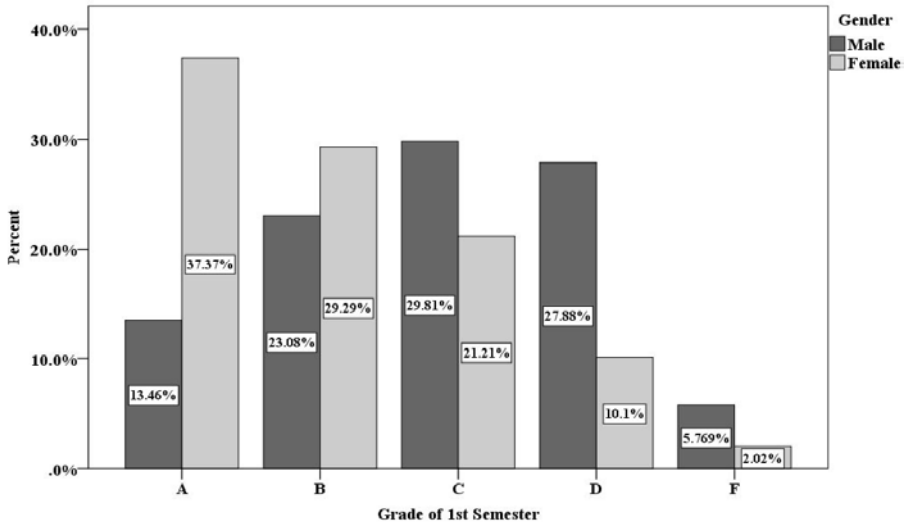

Figure 1: First semester grade of male versus female Omani school students.

Table 3: Overall Dietary Intake Patterns of Omani School Students

Dietary intake Patterns	Frequency (n)	Percent (%)
Breakfast consumption		
Never	19	9.4
Sometimes	66	32.5
Often	45	22.2
Always	73	36.0
Regular intake of daily all 3 meals		
Never	22	10.8
Sometimes	74	36.5
Often	63	31.0
Always	44	21.7
Fruits intake (≥ 2 serving/day)		
Never	48	23.6
Sometimes	55	27.1
Often	38	18.7
Always	62	30.5
Vegetables intake (≥ 3 serving/day)		
Never	77	37.9
Sometimes	32	15.8
Often	40	19.7
Always	54	26.6
Fish intake (≥ 2 serving/week)		
Never	48	23.6
Sometimes	15	7.4
Often	39	19.2
Always	101	49.8
Avoid drinking soft drinks (sugar sweetened beverages)		
Never	40	19.7
Sometimes	30	14.8
Often	70	34.5
Always	63	31.0
Try to reduce the intake of fast foods? (≤ 3 servings/ week)		
Never	10	4.9
Sometimes	45	22.2
Often	94	46.3
Always	54	26.6

Always: occurs 7days/week; Often: occurs 4-5days/week; Sometimes: occurs 1-2 days/week, Never: dose not occurs at all.

Table 4: Statistical Analysis of Gender Differences in the Dietary Intake Patterns of Omani School Students

Dietary Intake Patterns	χ^2	df	*P*-value
Consuming breakfast regularly	19.14	3	< 0.001*
Consuming daily all 3 meals regularly	19.48	3	< 0.001*
Fruits intake (≥ 2 serving/ day)	10.14	3	0.02*
Vegetables intake (≥ 3 serving/ day)	5.18	3	0.16
Fish intake (≥ 2 serving/ week)	12.70	3	< 0.001*
Do you avoid drinking soft drinks (sugar sweetened beverages)	16.35	3	< 0.001*
Try to reduce fast foods intake (≤ 3 servings/week)	3.80	3	0.28

Chi-square test (χ^2), df: degree of freedom, * Significantly difference, $P < 0.05$.

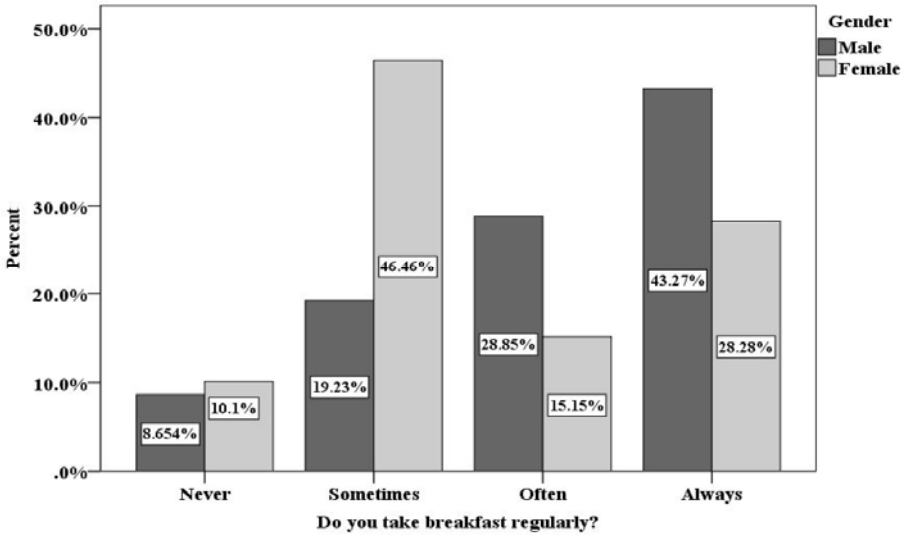

Figure 2: Breakfast consumption of male versus female Omani school students.

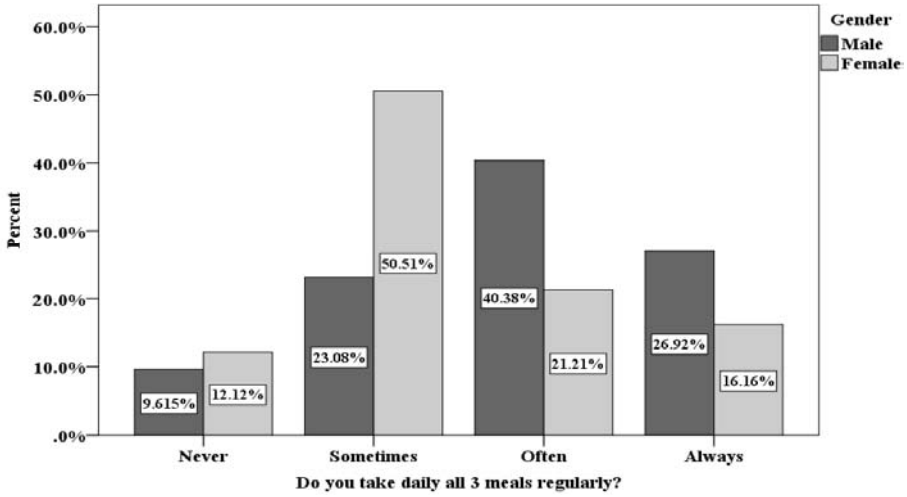

Figure 3: Regular intake of all 3 meals in male versus female Omani school students.

(P < 0.05) differences were observed in breakfast consumption, regular intake of all 3 meals, fruits, and fish intake, and in efforts to avoid taking soft drinks. Significantly (P < 0.05), more males were consuming breakfast (43.3%) and all 3 meals daily (26.9%) as compared to females 28.3% and 16.2%, respectively (Figures **2** and **3**). Also, significantly (P < 0.05) more males (34.6 %) consumed fruits as compared to females (26.3%). However, 33.3% of females and 14.4% of males did not consume fruits at all (Figure **4**). Significantly (P < 0.05) less females (39.4%) consumed fish as compared to males (59.6%). Whereas, 33.3 % of females and 14.4 % of males did not consume fish at all (Figure **6**). More females (34.3%) avoided drinking soft drinks as compared to males (27.9%). About 26% of males and 13% of females were taking soft drinks one to two times per day, respectively (Figure **7**). No significant differences (P < 0.05) were detected between males and females with respect to their vegetable intake and in their efforts in trying to reduce the fast food intake (Figures **5** and **8**). Overall, males showed preference in taking breakfast regularly, consuming daily all three meals, consuming fish and drinking soft drinks. Whereas the females preferred to avoid drinking the soft drinks as compared to males".

The data on the daily total energy and macronutrients intake in male and female Omani school students are given in Table **5**. The results indicated that the daily total energy and macronutrient intake in males was significantly (P < 0.05) higher as compared to female Omani school students. The study also focused in evaluating the relationship between various anthropometric indices and dietary intake patterns with the academic performance of Omani school students. The data showed no significant

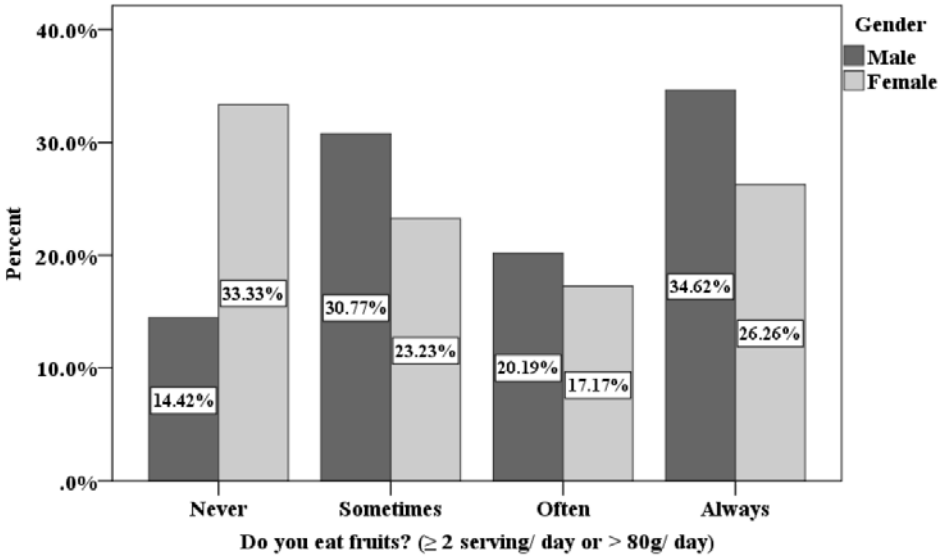

Figure 4: Fruits intake of male versus female Omani school students.

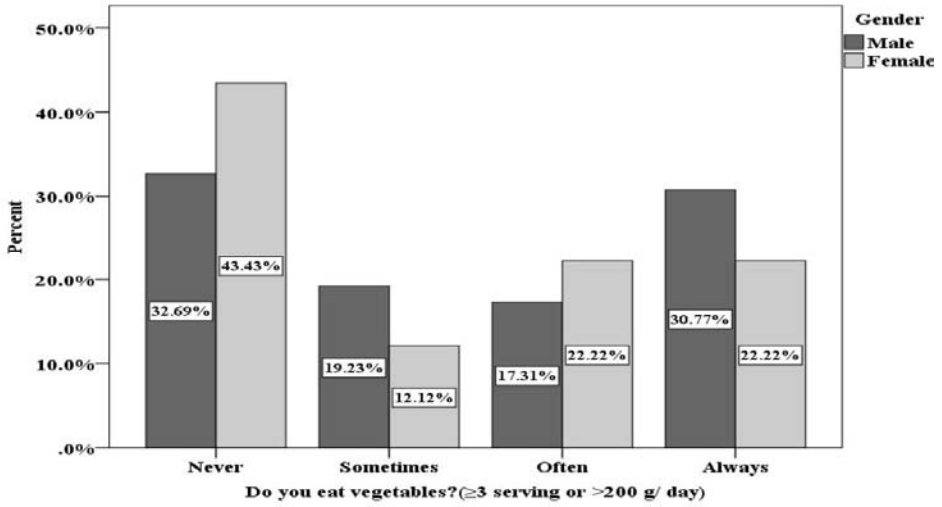

Figure 5: Vegetables intake of male versus female Omani school students.

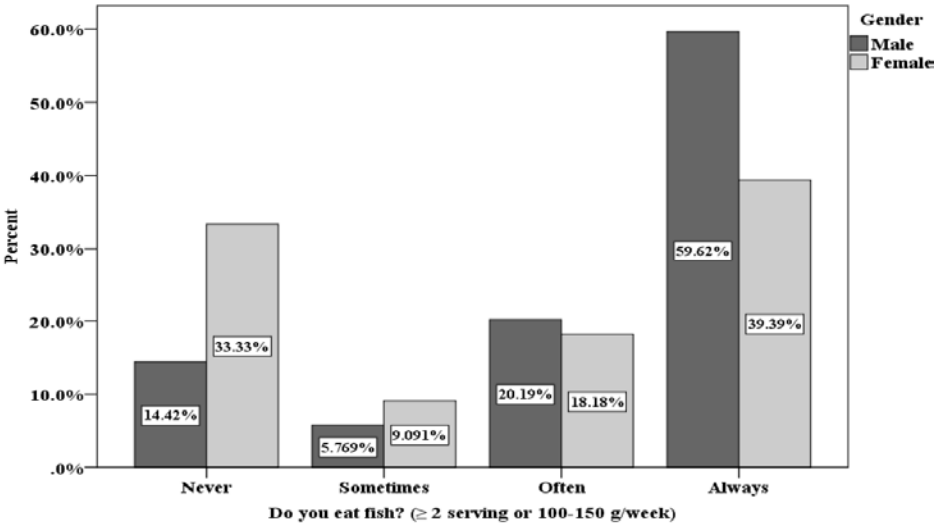

Figure 6: Fish intake of male versus female Omani school students.

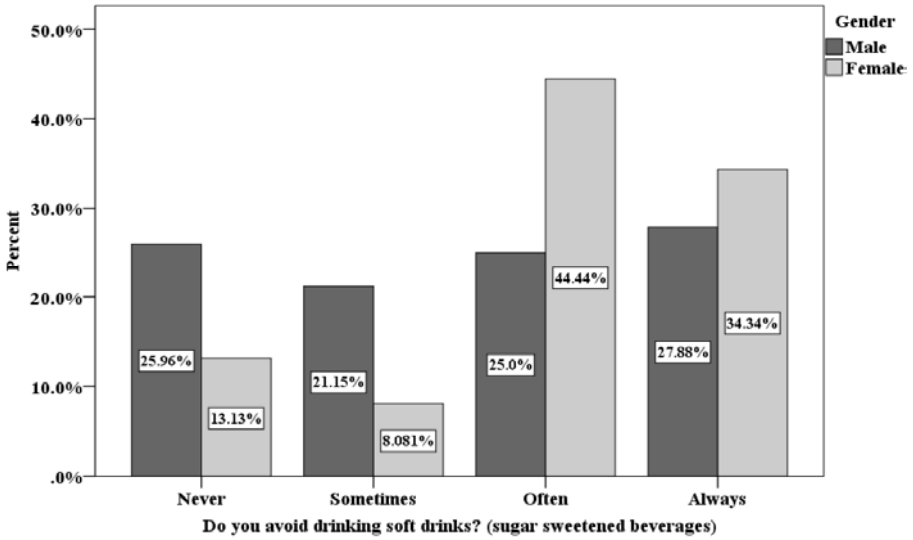

Figure 7: Avoiding soft drinks intake of male versus female Omani school students.

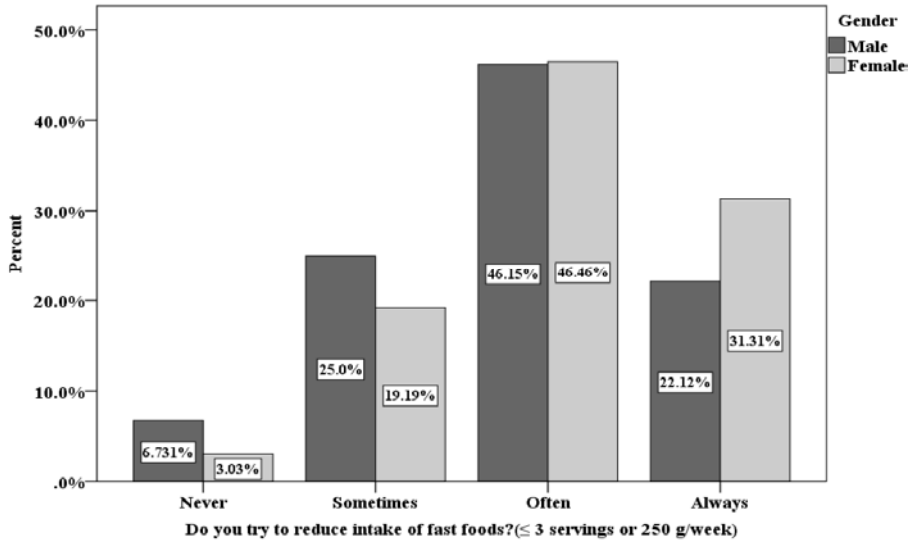

Figure 8: Try to reduce fast foods intake of male versus female Omani school students.

Table 5: Daily Total Energy and Macronutrients Intake of Male and Female Omani School Students

Total Daily Intake	Male (n =104)	Female (n= 99)	t	df	P-value
Energy (kcal)	2227 ± 630	1617 ± 461	7.85	201	< 0.001*
Protein (g)	84.03 ± 26.57	60.11 ± 20.58	7.14	201	< 0.001*
Carbohydrate (g)	308.36 ± 88.75	216.34 ± 57.19	8.73	201	< 0.001*
Fat (g)	74.46 ±23.90	57.73 ± 21.81	5.20	201	< 0.001*

Data is presented as mean ± Standard Deviation ($\bar{x}$ ± SD), t = unpaired Student's t-test, df = degree of freedom, *significantly different ($P < 0.05$).

association between various anthropometric indices and academic performance, except for waist-to-height ratio (WHtR) and academic performance (Table **6**). With respect to dietary intake patterns, the data only indicated a significant ($P < 0.05$) association between fish intake and avoiding soft drinks with the academic performance of Omani school students (Table **7**). Similarly, only a significant ($P < 0.05$) link was observed between the nutritional knowledge and the academic performance of Omani school students.

Table 6: Association of Various Anthropometric Indices with the Academic Performance of Omani School Students

Weight Status	Grade					χ^2	df	P-value
	A	B	C	D	F			
BMI-for-age [a]								
Sever Thinness	16.7	38.9	22.2	16.7	5.6	14.28	16	0.58
Thinness	34.6	11.5	26.9	19.2	7.7			
Normal	25.9	32.1	21.0	17.3	3.7			
Overweight	32.0	28.0	28.0	12.0	0.0			
Obesity	18.9	18.9	32.1	26.4	3.8			
WC [b]								
Not at risk	27.1	25.2	23.4	18.7	5.6	8.11	8	0.42
Overweight	28.1	37.5	18.8	12.5	3.1			
Obesity	20.3	21.9	32.8	23.4	1.6			
WHR [c]								
Not at risk	27.9	29.3	21.8	17.0	4.1	8.10	4	0.08
Overweight & Obesity	17.9	17.9	35.7	25.0	3.6			
WHtR [d]								
Not at risk	25.0	29.8	22.1	16.3	6.7	15.94	8	< 0.001*
Overweight	40.0	25.7	20.0	14.3	0.0			
Obesity	17.2	20.3	34.4	26.6	1.6			

Chi-square test (χ^2), df: degree of freedom *significantly different, $P < 0.05$, [a] Body mass index-for-age, [b] Waist circumference (WC), [c] Waist-to-hip ratio (WHR), [d] Waist-to-height ratio (WHtR).

Table 7: Association of Dietary Intake Patterns with the Academic Performance of Omani School Students

Dietary Intake Patterns	Grade					χ^2	df	P-value
	A	B	C	D	F			
Consumption of breakfast								
Never	15.8	15.8	26.3	36.8	5.3	17.03	12	0.15
Sometimes	28.8	27.3	21.2	15.2	7.6			
Often	20.0	26.7	40.0	11.1	2.2			
Always	27.4	27.4	20.5	23.3	1.4			
Daily intake of all 3 meals								
Never	18.2	18.2	22.7	31.8	9.1	14.84	12	0.25
Sometimes	29.7	27.0	23.0	14.9	5.4			
Often	15.9	27.0	34.9	19.0	3.2			
Always	34.1	27.3	18.2	20.5	0.0			
Fruits intake								
Never	22.9	25.0	20.8	20.8	10.4	15.82	12	0.20
Sometimes	29.1	16.4	36.4	16.4	1.8			
Often	23.7	34.2	15.8	23.7	2.6			
Always	24.2	30.6	25.8	17.7	1.6			

(Table 7). Continued.

Dietary Intake Patterns	Grade					χ^2	df	P-value
	A	B	C	D	F			
Vegetables intake								
Never	28.6	22.1	23.4	19.5	6.5	15.07	12	0.24
Sometimes	15.6	15.6	34.4	34.4	0.0			
Often	30.0	30.0	25.0	12.5	2.5			
Always	22.2	35.2	24.1	14.8	3.7			
Fish intake								
Never	18.8	20.8	29.2	20.8	10.4	23.51	12	0.02*
Sometimes	46.7	26.7	0.0	26.7	0.0			
Often	28.2	17.9	23.1	23.1	7.7			
Always	23.8	31.7	28.7	15.8	0.0			
Do you avoid drinking soft drinks?								
Never	22.5	12.5	30.0	30.0	5.0	22.98	12	< 0.001*
Sometimes	6.7	26.7	43.3	16.7	6.7			
Often	24.3	30.0	20.0	21.4	4.3			
Always	36.5	30.2	20.6	11.1	1.6			
Do you try to reduce fast foods intake?								
Never	10.0	50.0	30.0	10.0	0.0	20.06	12	0.07
Sometimes	20.0	31.1	28.9	15.6	4.4			
Often	18.1	24.5	28.7	24.5	4.3			
Always	44.4	20.4	16.7	14.8	3.7			

Chi-square test (χ^2), df: degree of freedom, * significantly difference, $P < 0.05$, Always: Occurs 7days/ week; Often: Occurs 4-5days/ week; Sometimes: Occurs 1-2days/ week, Never: Dose not occurs at all.

Table 8: Association of Nutritional Knowledge, Omani Diet Score, Daily Total Energy and Macronutrients Intake with Academic Performance of Omani School Students

Parameters	χ^2	df	*P*-value
Nutritional Knowledge	58.36	28	< 0.001*
Omani Diet Score	141.46	152	0.72
Daily Energy/Nutrients Intake			
Total calories	812.00	808	0.45
Total protein	789.48	796	0.56
Total carbohydrate	808.10	804	0.45
Total fat	812.00	808	0.45

Chi-square test (χ^2), df: degree of freedom *significantly different, $P < 0.05$.

Whereas all other parameters, such as Omani Diet Score, daily intake of total energy and macronutrients, did not show any association with the academic performance of Omani school students (Table **8**).

DISCUSSION

The present study explored the dietary intake patterns and nutritional status of Omani school students and their association with the academic performance of students. The results showed that as per BMI-for-age, the overweight and obesity rates in Omani school students were 12.3% and 26.1%, respectively, which are different from Oman Global School-based Student Health Survey (GSHS), which showed that the overweight and obesity rates in students were 31.3% and 12.7%, respectively [24].

This variability may be due to the smaller sample size in our study. The results based on other anthropometric indices such as waist circumference, waist-to-hip ratio, waist-to-height ratio showed similar trends for overweight and obesity in Omani school students. Significant differences were observed between male and female Omani school students, only for waist-to-hip ratio (WHR). These values were, however, below the cut off points, as suggested by Motlagh *et al*. [17], indicating that Omani school students were not at risk of overweight and obesity. Overall, the results showed that male students were inclined towards obesity, whereas female students were more in the overweight category. Similar results were reported by Zayed *et al*. [25], who observed no significant differences in anthropometric measurements of young Omani adolescents. Our results are also in line with the data presented by previous other studies related to the frequency of overweight and obesity in secondary school students from Dubai and the United Arab Emirates [26, 27].

Unhealthy dietary intake patterns are becoming common among school students, as reported by various studies from the Gulf countries [28-31]. Our results showed that many Omani school students were not following healthy dietary patterns as 23.6% of Omani school students did not eat fruits at all, 37.9% vegetables, 23.6% fish, and 19.7% took soft drinks one to two times per day. The unhealthy dietary patterns not only raise the risk of overweight, obesity, cardiovascular diseases, diabetes, hypertension and some types of cancer but may also affect the brain functioning due to lack of supply of essential nutrients [4, 13]. The results of this study indicated that only 36% and 21.7% of school students regularly consumed breakfast and daily all 3 meals, respectively. It was interesting to note that a higher number of male students (43.3% and 27%, respectively) were consuming daily breakfast and all 3 meals as compared to female students (28.3% and 16.1%, respectively). Our results confirm the findings of Musaiger *et al.* [28], who also observed that skipping breakfast was more common in females as compared to males. Skipping breakfast has been linked with increased weight gain, obesity, and poor cognitive functions and is linked to other adverse health effects such as higher serum cholesterol and higher blood pressure [8]. Students, who consumed breakfast regularly, had better food choices and higher daily nutrients intake than those who skipped breakfast [32]. Missing meals might make students to be at risk of poor nutrition, eating disorders, and unhealthy eating patterns [33].

More male students (34.6%) consumed fruits (≥ 2 serving/ day) as compared to females (26.3%), whereas no significant differences were observed in vegetable intake. Fruits and vegetables are a good source of a variety of micronutrients, which are critical to physical and mental functions and can lower depression, stress, and improved mood [11, 34]. Healthy dietary patterns decrease the risk of depression, whereas Western-style dietary patterns may increase the risk [34]. Similarly, more male students (59.6%) were consuming fish (≥ 2 serving/ week) as compared to female students (39.4%). Fish consumption has multiple benefits for health as it is a rich source of omega-3 polyunsaturated fatty acids (ω-3 PUFA), which are essential for optimal growth and development [7, 35]. It was interesting to note that more female students (34.3%) avoided drinking soft drinks as compared to male students (27.9%). Similar results were reported by Daradkeh *et al.* [36] for Qatari male adolescents and by Musaiger and Zagzoog [29] for Saudi adolescents. The consumption of sugar-sweetened beverages (SSB) can lead to development of obesity, hypertension, type 2 diabetes, dental caries, dyslipidemia, and fractures [37]. The people who consumed 1 to 2 serving/day of sugar-sweetened beverages (SSB) had a 26% higher risk of developing type 2 diabetes as compared to those who either did not drink or have low consumption of SSB [38]. No significant ($P < 0.05$) difference was observed between male and female students in their efforts in trying to reduce fast food intake. Similar results were observed by Musaiger *et al*. [28] for Bahraini school students. The nutritional knowledge is considered as one of the important factors in shaping healthy dietary patterns [39]. Female students had more nutritional knowledge than male students. However, both genders did not show enough nutritional knowledge for making healthy food choices as the average nutritional knowledge score for both males and females was below 50. Absence of enough knowledge about healthy food choices can negatively impact nutritional status and dietary habits. The average Omani Diet score for male and female students was 59 and 58, respectively, which is considered as low, indicating unhealthy dietary patterns. Both male and female Omani school students however showed having adequate daily energy and nutrients intake, which were within the dietary guidelines for healthy eating [40, 41]. Omani adolescents have been shown to have a high calorie intake, which was associated with overweight and obesity [25]. It is suggested that all public schools should have health education in their curricula to promote awareness about the intake of healthy foods.

Healthy school food programs must ensure that the vending machines in schools, should contain healthy options such as fruits and vegetables, water, milk, pure juices, low-fat snacks, and sandwiches and not the energy-dense junk foods and empty calories sugar-sweetened beverages [42].

The main objective of this study was to ascertain if there is any connection between dietary intake patterns and nutritional status of Omani school students with their academic performance. The data showed no significant correlation between various anthropometric indices and the academic performance of students, except for the waist-to-height ratio (WHtR). WHtR is a new and relatively accurate method to assess overweight and obesity in children and adolescents, and it showed a significant association with the academic performance [43]. Although the data from earlier studies have indicated a link between the dietary patterns and the academic performance [2, 6, 8-10, 13, 44], our results did not show any significant association between breakfast consumption, taking daily 3 meals, fruits, and vegetables intake and reduction of fast food intake with the academic performance. Our results only indicated a significant ($P < 0.05$) association between fish intake and avoiding soft drinks with the academic performance of Omani school students. Similarly, only a significant ($P < 0.05$) association was observed between the nutritional knowledge and the academic performance of Omani school students. All other parameters such as Omani Diet Score, daily intake of total energy and macronutrients didn't show any association with the academic performance of the Omani school students. It has been observed that undernourished children had poor academic performance as compared to well nourished children [2, 44]. The school students who participated in our study were well-nourished but showed unhealthy dietary patterns. Regular consumption of breakfast and daily all 3 meals have been shown to improve mood, cognition, and academic performance [8, 10]. It has been found that intake of fruits and vegetables has a significant positive association with the academic performance [6, 13], whereas the fast food intake was found to be negatively associated. This discrepancy in our results and the results from some previous studies might be because of some study limitations such as small sample size (203 participants) or use of grade for one semester only. The results of this study are in agreement with the data reported in previous studies, which linked higher fish intake with improved cognition, intuition and higher academic grades in school students [2, 7, 35]. Our results also coincide with the findings of Burrows *et al.* [45], who reported that increased intake of sugar-sweetened beverages was significantly related to lower test scores in grammar/punctuation, writing, and mathematical ability. The consumption of SSB can lead to the development of metabolic disorders, which may affect the student's academic performance [46]. The results of the present study showed a significant association between nutritional knowledge and academic performance. Lack of nutritional knowledge about healthy food choices and inappropriate health behaviours can negatively impact the nutritional status and dietary habits, which can affect the student's academic performance [47]. The school students should be encouraged to regularly consume a healthy diet. The educational programs to improve the nutritional knowledge of Omani school students are therefore essential to change their dietary intake patterns health behaviours.

CONCLUSION

The study demonstrated that most of the Omani school students were not following healthy dietary patterns that increased their risk of being overweight and obese as assessed by BMI-for-age, WC, WHR, and WHtR. Significant gender differences were observed regarding breakfast consumption, regular intake of daily 3 meals, fruits and fish intake, avoiding soft drinks, nutritional knowledge, total energy and macronutrient intake. Based on BMI, 12.3 % of students were overweight and 26.1% were obese. The students had poor nutritional knowledge and showed unhealthy dietary patterns as indicated by their poor Omani Diet Scores. Only fish intake, avoiding soft drinks, waist to height ratio (WHtR) and nutritional knowledge score showed significant associations with student's academic performance. Healthy dietary patterns and improved nutritional status of school students showed a positive association with their academic performance, suggesting that more focus must be placed in developing healthy dietary patterns. It is suggested that future research on this subject should be conducted with larger cohorts using grades in specific subjects or cumulative GPA at the end of school graduation to validate these findings. Finally, it is recommended that the Ministry of Education, school managements, and parents should focus more on promoting healthy eating patterns in school students.

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ETHICAL APPROVAL

The ethical approval of the study was obtained from the Ministry of Education (MoE), The Sultanate of Oman (Reference number: 2818220511 dated September 18, 2018).

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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