Nutritional and health status of medical students at a university in Northwestern Saudi Arabia

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ABSTRACT

الأهداف: تقييم الحالة الصحية، ومصادر الغذاء، والنشاط البدني، ومقاسات التغذية الصحية بين طلاب السنوات الأخيرة للطب.

الطريقة: أُجريت هذه الدراسة المقطعية بتوزيع طلبات الاستبيان على 194 طالب وطالبة من طلاب السنوات الثلاث الأخيرة للطب، وتم اختيار الطلاب بطريقة عشوائية ممنهجة وذلك خلال الفترة من يناير إلى مايو 2011م. وقد شمل الاستبيان الحالة الاجتماعية والاقتصادية، والتمرينات الرياضية اليومية، واسترجاع تفاصيل الغذاء للأربع وعشرين ساعة سابقة. وتم أخذ المقاسات الصحية وشملت مؤشر كتلة الجسم، ونسبة محيط الخصر لمحيط الأرداف، ومتوسط ضغط الدم، ومستوى السكر الصائم، وبروتين سي النشط، ودهون الدم. وتم عمل التحليل الغذائي بواسطة نظام تحليل الغذاء العالمي حيث يتم مقارنة كمية ونوع الغذاء بالتي أوصت بها جمعية القلب الأمريكية.

النتائج: مثلت النشويات المصدر الرئيسي للسعرات الحرارية للطلبة (72.1%)، ثم الدهون (19.4%)، فالبروتينات (8.4%). ومثلت الدهون والبروتينات ذات الأصول الحيوانية معظم مصادر الطاقة (5.3% مقابل 3.2%) وذلك بالمقارنة مع المصادر النباتية (11.6% مقابل 7.8%). و احتوت الأغذية على نسبة أقل من الموصى بها وذلك من الألياف (8.5% من الموصى)، والفيتامينات خصوصاً فيتامين د (14.2% من الموصى)، والأملاح (البوتاسيوم 31.3%، والزينك 40.7%، والمغنيسيوم 24.5%، والكالسيوم 47% من الموصى). وكان معدل انتشار زيادة الوزن بين الطلاب 34.5%، والبدانة 10.3%. وكان معدل انتشار اعتلال الدهون في الدم24.7%، وكان 56.2% من الطلاب لديهم زيادة في إفراز بروتين سي النشط. وقد وُجدت علاقة طردية بين متوسط السعرات الحرارية من جهة وكلاً من مؤشر كتلة الجسم (r=0.42, p=0.00)، وبروتين سي النشط (r=0.3, p=0.001). وقد وُجد أيضاً انتشار في قلة النشاط البدني (64.4%) بين الطلاب.

خاتمة: أظهرت هذه الدراسة أوجه القصور في العديد من المواد الغذائية الأساسية بين طلاب الطب، وارتفاع نسبة الاصابة بزيادة الوزن، والسمنة، و انتشار قلة النشاط. و تشير هذه النتائج إلى الحاجة لتحسين التغذية وتعزيز أنماط الحياة الصحية بين طلبة الطب السعوديين.

Objectives: To assess the nutrition and health status, nutrients intake, and physical activity among Saudi medical students.

Methods: A cross-sectional survey using a questionnaire, anthropometric measurements, and laboratory assessments was conducted from January to May 2011 on 194 randomly selected Saudi medical students at Taibah University, Madinah, Kingdom of Saudi Arabia. The adequacy of nutrient intake was compared with the recommended daily intake (RDI) per the National Research Council.

Results: Caloric intake was derived from carbohydrates (72.1%), fats (19.4%) and proteins (8.4%). Proteins and fats were obtained from a greater number of animal sources than of plant sources (5.3% versus 3.2% for proteins and 11.6% versus 7.8% for fats). There were low percentages of RDI of fibers (8.5%), most vitamins especially vitamin D (14.2%), and minerals (potassium (31.3%), zinc (40.7%), magnesium (24.5%), and calcium (47%). Overall, 34.5% of the students were overweight, and 10.3% were obese. Dyslipidemia was diagnosed in 24.7%, and 56.2% had high high-sensitivity C-reactive protein (hs-CRP). There was a positive correlation between the median caloric intake and both the BMI ($r=0.42$, $p=0.00$) and hs-CRP ($r=0.3$, $p=0.001$). Inactivity was prevalent among the students (64.4%).

Conclusion: This study showed deficiencies in several essential nutrients among medical students, and the prevalence of overweight status, obesity, and inactivity were relatively high. These results indicate the need to improve nutrition and promote healthy lifestyles among the medical students.

Saudi Med J 2012; Vol. 33 (12): 1296-1303

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Received 14th August 2012. Accepted 27th October 2012.

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Over the last decades, the Kingdom of Saudi Arabia (KSA) has faced marked changes in the demographics, socioeconomics, and public health. The increasingly higher economic development of KSA has resulted in a rapid Westernization of lifestyle habits.[1] The Westernization of dietary habits and lifestyle reflects the national increasing trend towards consumption of macronutrients including total food, fats, animal products, and refined foods.[2,3] In contrast, this new trend in the Saudi dietary patterns is accompanied by low consumption of vegetables and fruits, which are some of the main sources of essential micronutrients.[4,5] This unhealthy dietary pattern has increased the risks for cardiovascular diseases, cancer, obesity, diabetes, gallstones, and other chronic illnesses.[2] Changes in lifestyle and socioeconomic status in KSA have also had a significant impact on Saudis' physical activity. With the availability of modern techniques and entertainments, life has become more sedentary. Researchers found a steep decrease in the pattern of physical activity among Saudis during the last decades.[6] A study conducted on Saudi adults[7] showed that only a quarter of them were considered physically active, and 40% of them were inactive. Gender differences in physical activity do exist among Saudis,[7] which could be explained by the unique culture of the kingdom. A sedentary lifestyle carries the risk for obesity, type 2 diabetes,[8] and cardiovascular disease.[9] The potential adverse health consequences of this unhealthy lifestyle trend highlight an urgent need for increasing public awareness. Improving the population's knowledge, attitude, and behavior regarding diet and physical activity is urgent in order to shift the current national dietary habits closer to the desirable healthy dietary patterns and to encourage physical activity. In this study, our objectives were to assess whether the dietary intake among Saudi medical students meets the recommended daily intake (RDI) established by the National Research Council (NRC). We also assessed physical activity, socioeconomic status, and nutritional and health status, including weight and height, blood sugar, lipid profile, and biomarkers of underlying infection/inflammation (C-reactive protein [CRP]).[10] We selected medical students not only because college students are highly exposed to unhealthy eating habits,[11] but also because some will become physicians, and it is known that physicians' personal health habits are important predictors of the counseling their patients receive.[12-15] In addition, medical students in their final years are supposed to master the basic sciences that could influence their lifestyle behavior.

Disclosure. This study was funded by the Deanship of Scientific Research at Taibah University (grant number 66/427), Madinah, Kingdom of Saudi Arabia. The authors have no conflict of interests, and the work was not supported or funded by any drug company.

Methods. This cross-sectional study was approved and funded by the Deanship of Scientific Research at Taibah University as part of the project "Prevalence of Risk Factors for Coronary Heart Disease Among Saudi Students at Taibah University in Madinah, KSA". This study was conducted from January to May 2011 on Saudi medical students at the College of Medicine from the final 3 (clinical) years by systematic randomization using their computer numbers. This study was conducted according to the principles of the Declaration of Helsinki. All students had participated in the study after giving verbal consent. The total number of the students who were registered in the clinical years was 372 students, out of them 200 students (100 females and 100 males) were selected. The response rate was 97%, and the final sample size was 196 students (100 females and 96 males) with 4.87% confidence interval, and 95% confidence level. After a review of the questionnaire, pregnant students, students with chronic illness, smokers, and students on contraceptive pills, special diet, or nutritional supplements were excluded from the study, and replaced by other randomly selected students. The selected students were asked to answer the questionnaire at the medical center of the university, and then underwent physical examination and blood sampling. Their socioeconomic status was graded as low, middle, or high according to the income, education, and occupation of the students' parents.[16] A separate 9-item sorted-out from the "International Physical Activity Questionnaire (IPAQ-SF)" was used to assess physical activity.[17] The analysis of the food consumed and dietary intake of the students in this study relied on 24-hour dietary intake information.[18] Students were interviewed by a registered dietician to report all food and beverages they had consumed during a 24-hour period. Then each item was described in as much detail as possible. The students were instructed to report everything eaten or drunk, including meals, snacks, and coffee breaks for the past 24 hours. The questionnaire included details regarding the exact portions of food consumed (serving size), type of food (fortified, skimmed, low fat, or full fat), method of preparation (boiled/baked/fried/breaded), brand name (commercial/ready-to-eat/

brand), and parts eaten (whole item/half). Systolic (SBP) and diastolic blood pressures (DBP) were measured, and anthropometric measurements were taken from all individuals, including weight in kilograms (kg), height, waist, and hip in centimeter (cm). The mean blood pressure (MBP) was subsequently calculated as DBP + 1/3 (SBP-DBP). Abnormally high MBP was defined as ≥110 mm Hg. The body mass index (BMI) (weight [kg]/height [m^2]), and waist-to-hip ratio (WHR) were calculated. Students were overweight if their BMI was ≥25%, and obese if it was ≥30%. Increased WHR was defined as ≥0.9 in males, and ≥0.8 in females.[19]

Morning samples were collected after a 12-hour fast. Aliquots (5 ml) of venous samples were withdrawn, and aliquots were collected into tubes under aseptic conditions as follows: sodium fluoride plasma for determination of glucose; and serum for determination of lipid profile (total cholesterol, high-density lipoprotein cholesterol [HDL-C], low-density lipoprotein cholesterol [LDL-C], and triglycerides). A high-sensitivity enzyme-linked immunosorbent assay (ELISA) was used to evaluate high-sensitivity CRP (hs-CRP) levels. Impaired fasting glucose was defined as levels ≥100 mg/dl. Students were identified as having dyslipidemia if one or more of the measured lipid profile items were as follows; if total cholesterol ≥200 mg/dl, triglycerides ≥150 mg/dl, LDL ≥130 mg/dl, HDL <50 mg/dl in females, and <40 mg/dl in males. The hs-CRP ≥1 mg/L is considered to be risky, but students with hs-CRP >10 mg/L were excluded from the statistical analysis.[20]

Dietary intake. Food records were analyzed according to the World Food Dietary Assessment System, which facilitates rapid dietary assessment using an IBM-compatible personal computer.[21] The adequacy of each nutrient intake was evaluated by quantifying it as a percentage of RDI according to the National Research Council.[22,23] Each student's intake of food energy, protein, vitamins, and minerals was converted to the percentage of RDI of the nutrient for the student's age and gender. Gross intakes were reported for the dietary components, for which the RDIs were not applicable; intakes of fat and carbohydrate were measured in grams, whereas the intakes of sodium and cholesterol were measured in milligrams.

Statistical analysis. Statistical evaluation of all data was carried out using the Statistical Package for Social Sciences version 17 for Windows (SPSS Inc, Chicago, IL, USA). Quantitative data are presented as means and standard deviation, and as the median for variables with wide variance. Comparison between different groups were performed by independent-samples T test, ANOVA, and nonparametric tests (Mann-Whitney test). Pearson's correlation coefficient test was used to test the association between different variables. Excel was used to generate **Figure 1**. All tests were 2-tailed and considered significant when $p<0.05$.

Results. *Clinical data (Table 1).* The mean age of students was 21.06 ± 1.85 years without gender differences. Male and female students were matched by activity and their socioeconomic level. Physical inactivity was found to be more prevalent (64.4%) than minimal activity (21.6%) or activity (13.9%). Almost half of the students (51.1%) belonged to the middle socioeconomic status. The mean BMI was 24.83 ± 4.74 kg/m^2 and was higher among male than female students (26.26 ± 5.27 kg/m^2 versus 23.49 ± 3.73 kg/m^2, p=0.000) with significantly higher WHR (1.25 ± 0.43 versus 1.10 ± 0.30, p=0.006).

Measures of nutritional and metabolic health status (Table 1 & Table 2). High BMI was detected in 87 (44.9%) students; 67 (34.5%) were overweight, and 20 (10.3%) were obese. Among the female students, 22 were overweight (22%), and 6 were obese (6%). Among male students, 45 were overweight (47.9%), and 14 were obese (14.9%). Increased WHR was detected in 33 students (17%); 10 of these were females (10%), and 23 were males (24.5%) with a significant difference (p=0.007). Increased blood pressure was detected in 4 students (2.1%), 3 females (3%), and one male (1.1%) (**Table 2**). Female students showed a significantly higher fasting blood sugar than male students (85.53 ± 16.71 mg/dl versus 81.03 ± 8.62 mg/dl, p=0.021), but none was found to be diabetic. Impaired fasting glucose was found in 7 students (3.6%) (4 females [4%], and 3 males [3.2%]). Compared to female students, male students had significantly higher serum triglycerides

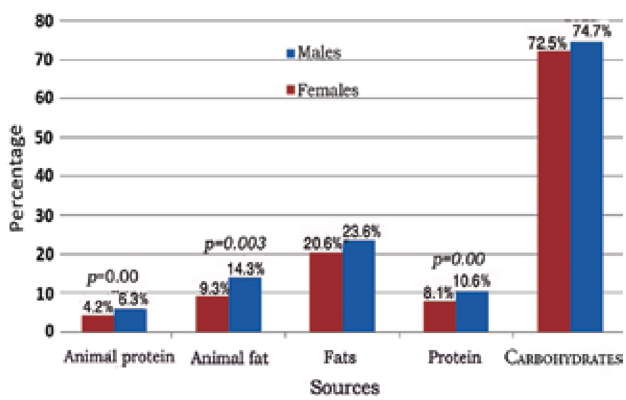

Figure 1 - A comparison between male and female medical students macronutrients' caloric distribution.

Table 1 - Clinical and laboratory data of students included in a study conducted at Taibah University in Madinah, Kingdom of Saudi Arabia.

Variables	All students N=194	Females N=100	Males N=94	*P*-value
Physical activity, n (%)				0.352
Inactive	125 (64.4)	65 (65.0)	60 (63.8)	
Minimally active	42 (21.6)	24 (24.0)	18 (18.1)	
Active	27 (13.9)	11 (11.0)	16 (17.0)	
Socioeconomic level, n (%)				0.077
Low	51 (26.3)	33 (33.0)	18 (19.2)	
Middle	99 (51.1)	45 (45.0)	54 (57.5)	
High	44 (22.7)	22 (22.0)	22 (23.4)	
Body mass index, kg/m^2	24.83 ± 4.74	23.49 ± 3.73	26.26 ± 5.27	0.000
Waist-to-hip ratio	1.17 ± 0.4	1.10 ± 0.30	1.25 ± 0.43	0.006
Mean blood pressure, mmHg	90.51 ± 4.90	90.02 ± 5.45	91.03 ± 4.20	0.154
Fasting blood glucose, mg/dl	83.35 ± 13.57	85.53 ± 16.71	81.03 ± 8.62	0.021
Total cholesterol, mg/dl	178.73 ±33.14	182.33 ± 40.68	174.17 ± 21.98	0.087
LDL cholesterol, mg/dl	94.60 ± 26.52	77.25 ± 22.90	113.05 ± 21.49	0.00
HDL cholesterol, mg/dl	52.34 ± 20.07	59.92 ± 21.38	44.29 ± 4.16	0.00
Triglyceride, mg/dl	54.62 ± 29.16	39.91 ± 27.88	70.27 ± 21.38	0.00
hs-CRP, mg/l	2.69 ± 2.02	2.48 ± 1.73	2.52 ± 1.69	0.141

Values are expressed as mean ± standard deviation for continuous variables. LDL - low-density lipoprotein; HDL - high-density lipoprotein; hs-CRP - high-sensitivity C-reactive protein

Table 2 - Abnormally high measures of nutrition health status among students included in a study conducted at Taibah University in Madinah, Kingdom of Saudi Arabia.

Variables	All students N=194	Females N=100 n (%)	Males N=94	*P*-value
Obesity status based on BMI				
Increased BMI	87 (44.9)	28 (28.0)	59 (62.8)	0.000
Overweight (BMI >25%)	67 (34.5)	22 (22.0)	45 (47.9)	
Obesity (BMI >30%)	20 (10.3)	6 (6.0)	14 (14.9)	
High waist-to-hip ratio (≥0.9 in males and ≥0.8 in females)	33 (17.0)	10 (10.0)	23 (24.5)	0.007
High mean blood pressure	4 (2.1)	3 (3.0)	1 (1.1)	0.344
Impaired fasting blood glucose	7 (3.6)	4 (4.0)	3 (3.2)	0.763
Dyslipidemia	48 (24.7)	25 (25.0)	23 (24.5)	0.932
hs-CRP ≥1 mg/l	109 (56.2)	52 (52.0)	57 (60.6)	0.133

BMI - body mass index, hs-CRP - high-sensitivity C-reactive protein

Table 3 - Macronutrient intake and percentage of recommended daily intake (%RDI) among medical students included in a study conducted at Taibah University in Madinah, Kingdom of Saudi Arabia.

Variables	All students	Female students	Male students	*P*-value
		Median intake (%RDI)		
Total calories	2314.2 (93.5)	2247.7 (104.1)	2339.6 (89.8)	0.021
Carbohydrates intake, gm	409.1 (162.9)	389.3 (192.3)	423.2 (118.7)	0.000
Protein intake, gm	48.8 (96.6)	44.8 (97.3)	54 (86.3)	0.995
Animal source, gm	28.3	26	32.8	0.001
Fat intake, gm	40 (81.9)	40 (79.2)	40.4 (91.3)	0.375
Animal source, gm	25.6 (118.9)	17.9 (84.6)	27.7 (151.9)	0.014
Cholesterol, mg	254.2 (84.7)	240.5 (80.2)	302.4 (100.8)	0.001
Fibers, gm	2.5 (8.5)	2.6 (8.0)	2.4 (9.5)	0.658

Significant difference between male and female students using the median %RDI except for animal protein, which used the median intake.

level (70.27 ± 21.38 mg/dl versus 39.91 ± 27.88 mg/dl, p=0.000), much higher LDLc level (113.05 ± 21.49 mg/dl versus 77.25 ± 22.90 mg/dl, p=0.000), and a lower serum level of HDLc (44.29 ± 4.16 mg/dl versus 59.92 ± 21.38 mg/dl, p=0.000) (**Table 1**). Almost a quarter of the students (48 students) (24.7%) had dyslipidemia (25 females [25%], and 23 males [24.5%]). More than half of the students (56.2%) had high hs-CRP >1 mg/l, with no differences by gender (**Table 2**).

Caloric and macronutrients intake and sources (Figure 1 and Table 3). Most caloric intake was derived from carbohydrates (72.1%), followed by fats (19.4%) and proteins (8.42%). The percentage of protein and fat calories derived from animal sources was higher than that from plant sources (5.3% versus 3.2% for protein, and 11.6% versus 7.8% for fat). In addition, the caloric intake of animal proteins and fats were significantly higher among males than among females (p=0.001 for proteins, and p=0.035 for fats). Significantly higher macronutrients caloric intakes were detected in females than in males (p=0.00). The median carbohydrates intake was 162.9% of RDI, and was significantly higher in the females (192.3% RDI) than in the males (118.7% RDI) (p=0.000). Intake from animal sources was significantly higher in males (32.8 g) than in females (32.8 gm) (p=0.001). The median total daily fat intake was <65 gm (actual: 40 g), and provided <35% of calories (19.4%) (**Figure 1**) (which met the international recommendations). The median cholesterol daily intake was less than 300 mg in females, the % of RDI for cholesterol was significantly higher in males than in females (100.8% RDI versus 80.2% RDI, p=0.001). Both genders were found to consume very low levels of dietary fibers (median: 8.5 %RDI).

Minerals and vitamins intake (Table 4). There were low percentages of RDI of potassium (31.3%), zinc (40.7%), magnesium (24.5%), and calcium (47%), with much lower potassium and magnesium levels among males (p=0.001 and p=0.000), and lower calcium levels among females (p=0.003). The %RDI of iron was low among females only, who had a significantly lower number of animal sources than did the males (2.2 mg versus 3.6 mg, p=0.002). All intakes of vitamins were low (<70%) in both genders, and the most severe deficiencies were for vitamin D (14.2%), B2 (49.4%), folic acid (53.6%), and niacin (67.5%). Males showed significantly lower %RDI than females for vitamin A (9% versus 40%, p=0.000), vitamin C (18.4% versus 71.6%, p=0.019%), vitamin B1 (41.3% versus 50.9%, p=0.03), vitamin B6 (19.5% versus 43.1%, p=0.000), and vitamin E (37.7% versus 63.4%, p=0.029).

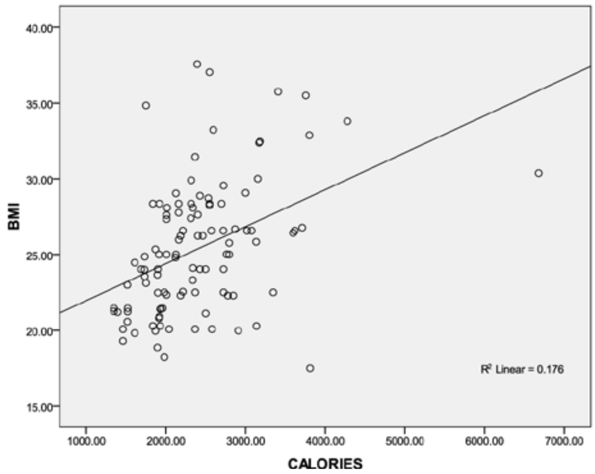

Figure 2 - Positive correlation between the median caloric intake and body mass index (BMI).

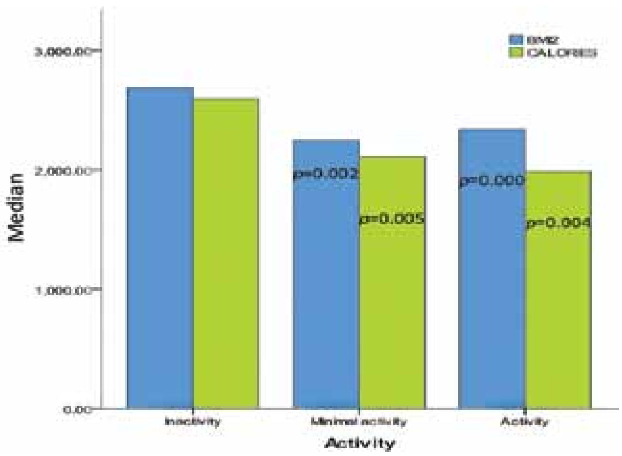

Figure 3 - Increased median caloric intake and body mass index (BMI) in students with physical inactivity compared with both minimally active and active students.

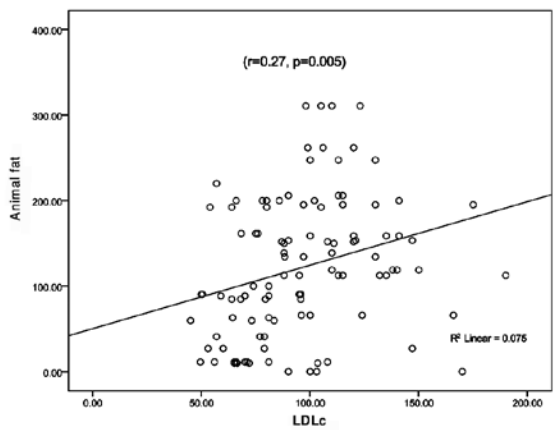

Figure 4 - Positive correlation between the animal fat intake and low-density lipoprotein cholesterol (LDLc).

Table 4 - Minerals and vitamins intake and their percentage of recommended daily intake (RDI) among medical students.

Classification	All students		Females		Males		*P*-value
	Median (%RDI)						
Minerals, trace elements intake, mg							
Sodium	1822.3	(82.3)	1721.9	(71.8)	1932.6	(82.3)	0.083
Potassium	1202.4	(31.3)	1461.2	(41.8)	1056.8	(31.5)	0.001
Zinc	5.7	(40.7)	5.2	(40.0)	6.1	(40.7)	0.060
Magnesium	139.5	(24.5)	167.5	(54.0)	98	(24.5)	0.000
Calcium	398.4	(47.0)	365.4	(34.9)	428	(46.9)	0.003
Phosphorous	732.8	(112.0)	693	(75.6)	799.4	(112.0)	0.000
Iron	8.54	(91.0)	6.9	(45.9)	9.1	(91.0)	0.000
Animal iron	2.7		2.2		3.6		0.002
Vitamins intake							
Vitamin A, µg RE	362	(9.0)	320	(40.0)	451.2	(9.0)	0.000
Vitamin C, mg	22.4	(18.4)	85.5	(71.6)	10.4	(18.4)	0.019
Vitamin D, mg	0.29	(14.2)	0.27	(7.3)	0.6	(14.2)	0.610
Vitamin B1, mg	0.6	(41.3)	0.56	(50.9)	0.6	(41.3)	0.030
Vitamin B2, mg	0.74	(49.4)	0.61	(46.0)	0.88	(49.4)	0.0390
Vitamin B6, mg	0.56	(19.5)	0.69	(43.1)	0.39	(19.5)	0.000
Niacin, mg	11.6	(67.5)	11.2	(55.9)	12.8	(67.5)	0.542
Vitamin B12, µg	1.03	(69.0)	0.95	(70.0)	1.25	(69.0)	0.803
Folic acid, µg	107.2	(53.6)	107.2	(59.5)	107.2	(53.6)	0.323
Vitamin E, mg TE	3.9	(37.7)	5.1	(63.4)	3.8	(37.7)	0.029

RE - microgram of retinol equivalent; TE - milligram of alpha tocopherol equivalent.
Significant difference between male and female students using the median RDI

Relations between different parameters (Figures 2-4). A positive correlation between the median caloric intake and the BMI was detected (r=0.42, *p*=0.00) (**Figure 2**). The inactive students tended to consume significantly higher caloric diets than did the minimally active students (*p*=0.005) and the active students (*p*=0.004) (**Figure 3**). The inactive students had significantly higher BMIs than did the minimally active students (*p*=0.000) and active students (*p*=0.000) (**Figure 3**). There was a positive correlation between hs-CRP and caloric intake (r=0.3, *p*=0.001). The WHR correlated positively with both triglycerides (r=0.33, *p*=0.000), and LDLc serum levels (r=-0.29, *p*=0.000), and negatively with HDLc (r=-0.33, *p*=0.000). Serum triglycerides correlated positively with protein intake (r=0.25, *p*=0.01), and LDLc correlated with animal fat intake (r=0.27, *p*=0.005) (**Figure 4**).

Discussion. In this study, physical inactivity was prevalent among Saudi medical students (64.4%) who belonged to different socioeconomic levels. Their diet was characterized by excessive amounts of carbohydrates, high animal sources of proteins and fats, and low amounts of fibers, minerals, and vitamins. These dietary characteristics are different from the traditional Saudi diet that consists mainly of dates, milk, vegetables, fruits, whole wheat bread, and fish. These findings, however, are in parallel with the recent lifestyle changes of the whole kingdom.[1-6] It appeared that the medical knowledge acquired during the initial basic sciences years in school failed to prevent the medical students from adopting the new emerging lifestyle habits. Sugar consumption is known to be high in the traditional Saudi diet, but has been shown to be continually increasing in the new dietary trends,[5,24] as was also shown in our study. These dietary changes are expected to lead to obesity,[2,5-7,24,25] Several studies have indicated that obesity is a major public health issue in Arab Gulf countries with the highest prevalence of obesity among adults.[26] The association between dietary changes and obesity was also seen in our results, and a large percentage of the students (44.9%) were overweight, or obese with a male predominance (62.8% of males versus 28% of females, *p*=0.000); in addition, a positive correlation was observed between the median caloric intake and BMI (**Figure 2**). Our medical students showed higher rates of obesity among males than females, contrary to findings reported by the WHO,[26] but similar to those of other Arab countries.[11,27] A possible explanation is that there is increased access to fast food for males compared with that for females. Although no correlation was observed between BMI and lipid parameters, the WHR correlated positively with triglycerides and LDLc, and negatively with HDLc, reflecting the known association between abdominal obesity and dyslipidemia.[28] Our results also showed that inactivity was associated with increased median caloric intake and BMI (**Figure 3**). These findings could reflect the combined role of both diet and physical activity regarding weight gain.

In this study, the most prevalent abnormal nutritional measure was the elevated hs-CRP level (56.2%). Plasma hs-CRP is an inflammatory marker that has recently been used as a cardiovascular risk assessment tool. In our study, the association between hs-CRP and caloric intake needs explanation, and may represent a link between atherogenic diet and pathological atherosclerosis.[29] The second most important observation in the current work was the high prevalence of dyslipidemia among Saudi medical students (24.7%), especially male students (**Table 1 & Table 2**). This prevalent dyslipidemia could partially be explained by the consumption of a high animal fat and protein diet. This is supported by the findings of a strong relationship between triglycerides and protein intake, and between LDLc and animal fat intake (**Figure 4**). Female students showed significantly higher fasting blood sugar levels than did male students (p=0.021), and a more or less similar prevalence of impaired fasting glucose (4% versus 3.2%). Despite the absence of a significant correlation with the dietary parameters, these findings could be explained by the increased caloric (104.1%) and carbohydrates intake (192.3%) among females in this study.

Fresh fruits and vegetables are known rich sources of dietary fibers, minerals, and vitamins.[6] Therefore, the combined low intake of minerals, vitamins, and fibers that was found in our study could be explained by low intakes of fresh fruits and vegetables. Our results also showed that potassium, zinc, magnesium, and calcium intakes were less than 50% of RDIs, and most vitamin intakes were less than 70%. The RDI of iron was lower in females only, who had significantly lower intakes from animal sources than did males (p= 0.002). In accordance with our findings, Saudi researchers[20-32] found that the iron intake of Saudi males but not of females was adequate compared with RDI. The females showed combined low calcium and iron intake despite their known increased needs for these 2 micronutrients. These micronutrient deficiencies in the female medical students could be explained by their low number of animal sources of food intake (**Table 3**). The traditional Saudi diet is known to be deficient in some micronutrients. In the current study, vitamin D intake appeared to be the lowest (14.2%) among all vitamins. Despite the sunny weather, vitamin D deficiency is very prevalent in KSA and affects all ages and both genders.[33-38] The exact etiology of this vitamin D deficiency is not known, and is probably multifactorial in nature.[6]

The main limitation of this study was the difficulty to record the exact ingredients of the students' mixed dishes and any added food. Another limitation was the absence of a standardized program for dietary measures using Saudi dietary allowances. Dietary allowances for the Saudi population were developed previously, but the method was not validated.[2] Another limitation was the wide variation in the dietary intake among the students that necessitated the use of the median and not the mean for measurement of the central tendency of dietary variables. In addition, there was a complex interaction between different dietary variables, physical activity parameters, socioeconomic status, and male/female factors, which makes it difficult to explain abnormalities seen in health measures.

In conclusion, this study addressed the concerns regarding high intakes of carbohydrates and animal foods and low intakes of fibers, minerals, and vitamins coupled with low physical activity and their impact on nutritional and health status measures among medical students. We recommend that medical colleges in KSA implement strong public health teaching courses that focus on the basics of healthy lifestyles and nutrition-related diseases. Further research using clinical trials is needed to establish a causal relationship between dietary habits and abnormalities in nutritional health status.

Acknowledgment. *The authors gratefully acknowledge Prof. Manal Abdulrahman, Taibah University, Madinah, Kingdom of Saudi Arabia for her important contributions in interviews of medical students for their dietary recall. The authors are also indebted to all medical students who had participated in the study for their outstanding cooperation.*

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