The association between body mass index and academic performance

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ABSTRACT

الأهداف : دراسة العلاقة بين مؤشر كتلة الجسم والأداء الأكاديمي للطلاب من مدينة الطائف، المملكة العربية السعودية باستخدام المعدل التراكمي

الطريقة : هذه دراسة مستعرضة تضم الطلاب من المدارس المتوسطة والثانوية التي تقع في مدينة الطائف، المملكة العربية السعودية بين أبريل 2014 ويونيو 2015. وقد تم قياس الطول والوزن ومؤشر كتلة الجسم. سُجلت عوامل الخطر ذات الصلة بما في ذلك العادات الغذائية والنشاط وتعليم الوالدين ونمط النوم والتدخين.

النتائج : شملت الدراسة إجمالي 14 مدرسة متضمنه 424 طالب وطالبة. يعاني 24.5% إما من زيادة الوزن أو السمنة. وكان متوسط العمر 15.44 سنة، وكان 74.8% من الطلاب الذكور، وكان53.8% من طلاب المدارس الثانوية، وحضر 83.7 % المدارس العامة. وكان معدله العام نفسه 82.44% وكان المعدل المتوسط للمواد العلمية 70.91%. لم يوجد فرق بشكل ثابت كبير في مؤشر كتلة الجسم بين هؤلاء الذين حققوا 90%< من الصف العام مقارنة مع أولئك الذين حققوا 90%>. أظهرت التحليل البُعدي اللاحقpost hoc 1-way أن الطلاب يعانون من السمنة المفرطة يؤدون أسوأ في الفيزياء من أقرانهم الوزن الطبيعي (p=0.049). الطلاب الذين حققوا 90%<بتقدير عام هم على الأرجح يدرسون في مدارس خاصة (p<0.05)، ويعيشون مع والديهم (p=0.013)، وكان الآباء المتعلمين (p=0.037)، والحصول على النوم الأمثل (p<0.05، و نادرا ما تناولوا طعامهم خارج المنزل (p<0.05) .

الخاتمة : لا توجد علاقة بين مؤشر كتلة الجسم والأداء المدرسي، إلا في نتائج الفيزياء حيث أن أداء الطلاب الذين يعانون من السمنة المفرطة أسوأ من الطلبة ذوي الوزن الطبيعي .

Objectives: To examine the relation between body mass index (BMI) and the academic performance of students from Taif city, Kingdom of Saudi Arabia (KSA) using the grade point average (GPA).

Method: A cross-sectional study that includes students from intermediate and high schools located in Taif city, KSA between April 2014 and June 2015. Height and weight were measured and BMI calculated. Related risk factors including dietary habits, activity, parent's education, sleeping pattern, and smoking were recorded.

Result: A total of 14 schools included 424 students. 24.5% were either overweight or obese. The mean age was 15.44 year, 74.8% of the students were male, 53.8% were high school students, and 83.7% attended public schools. The mean overall GPA was 82.44% and the mean GPA for science subjects was 70.91%. No statically significant difference in the BMI was found between those who achieved >90% of the overall grade compared with those who achieved <90%. Post hoc 1-way-analysis of variance showed that obese students were performing worse in physics than normal weight peers ($p=0.049$). Students who achieved >90% overall grade are more likely to attend private school ($p<0.05$), live with their parents ($p=0.013$), having educated parents ($p=0.037$), getting optimal sleep ($p<0.05$), and they rarely eat their food outside their home ($p<0.05$).

Conclusion: There was no correlation between the BMI and school performance, except in physics results where obese students perform worse than normal-weight students.

Childhood obesity is associated with a higher chance of premature death and disability in adulthood, according to the World Health Organization.[1] Obesity and excessive weight affect Saudi adolescent (39.9-45.6% males and 30.4-38.7% females). Unfortunately, this

figure of obesity among Saudi children and adolescents are still increasing.[2] Studies that evaluated the impact of diet on education identified that students with insufficient nutrition perform poorly in the classroom. Contributing factors to poor nutrition are various and consumption of fast food is one of them. Students who consumed above the average amount of fast food show a significant association with lower test scores in math and reading.[3] Although children who are overweight achieved poor result on math and reading tests when compared with their normal-weight peers.[3] In a study of inner city middle-school students, it was found that students who did not consume breakfast tend to have lower academic performance, whereas students who participated in school breakfast programs had a higher level of nutrient intake, and showed improvements in academic achievement and psychosocial functioning.[4] Also, students who have a low level of physical activity are more likely to be obese and also more likely to have a lower grade point average (GPA).[5] Academic performance is generally considered to be related to cognitive and memory functions.[7] Given the negative association of obesity with cognitive and memory functions, being overweight or obese might have a negative impact on the academic achievement of adolescents.[8] Also, weight-based teasing is considered the main impulse for developing psychosocial outcomes in obese or overweight adolescents, which negatively affects their self-confidence and quality of life.[9] They may develop low self-esteem as a consequence of being overweight or obese that could be translated into missed school. Accordingly, if being overweight causes a child to miss school, he/she might suffer academically as a short outcome.[10,11] Nevertheless, epidemiological studies which validate the correlation between being overweight or obese and adolescents' academic performance are limited. For that reason, the purpose of this study was to examine the relation between Body mass index (BMI), waist circumference (WC), and the academic performance of the student using the GPA. We also assessed the association of this with the other related risk factors that may affects psychological and social outcomes of obese life.

Methods. *Participants.* A cross-sectional descriptive study that includes students from the intermediate and high schools located in Taif city, Kingdom of Saudi

Arabia was conducted between April 2014 and June 2015. Permission was taken from the local authority in Taif that represent the Ministry of Education locally to obtain data regarding weight, height, waist circumference, and the academic achievement data. We included intermediate and high School students who range in age from 12-18 years who were willing to participate in the study. We excluded any students with any chronic medical illness, existing psychiatric disorders, and any students with learning disabilities.

A total of 14 schools, which was randomly selected were included. Seven of them were High Schools; 2 of those were for female students. The other 7 were Intermediate schools and 2 of them were for female students. Twelve schools out of 14 were public schools and the rest of them were private schools. In each school that was visited, one or 2 classrooms were randomly selected.

Procedure. Each student's height and weight were measured by the researchers and BMI was calculated according to the formula (Weight (kg)/height (m)^2). BMI was categorized into 4 classes: underweight (BMI <18.5), normal (BMI 18.5-<24.9), overweight (BMI 25-<30), and obese (BMI >30).[12] Access to each participant academic performance (marks/GPA) in the science subjects and overall GPA was given to the researchers. We evaluated the overall student's academic achievement for all subjects using the GPA and we also calculated the mean GPA for the science subjects both separately and together in the past year to assess academic performance for each student. The science subjects that we evaluated for each student were math, physics, chemistry, and biology.[13] We divided the cohort into 2 groups based on the overall GPA; students who achieved >90% were considered to be in the high (excellent) academic performance group and those who achieved <90% were considered to be in the low academic performance group.

The study included a total of 424 male and female students whom were willing to participate. The personal information was collected through an interview and self-reported questionnaire. This questionnaire was tested in one school prior to the data collection phase to check for errors, ambiguities, and redundancies. The researchers sat with the respondents, explained the rationale of the study and the process, and took consent from them verbally. They handed over the questionnaire to be completed immediately. The respondents were given adequate time to fill in the questionnaire and the researchers were available to answer any related questions. Information regarding related factors, such as the eating habits, including

eating breakfast at home, where to eat dinner, where to eat lunch, frequency of eating vegetables and/or fruits per week, the frequency of eating from outside home and the frequency of consuming fast food per week were self-reported. A sedentary lifestyle was identified as those whom perform exercises for a duration that is less than 150 min per week in addition to method of transportation to school.[14] Sleeping hours per night data was obtained and categorized into <6 hours, 6-8 hours, and >8 hours and the optimum was considered to be for those who sleep 6-8 hours per night.[14] Social related data, such as smoking habits, parent's education, working, retirements, ranking among sibling, and living with both parents were also recorded.

The primary outcome of the study is to evaluate the relationship between BMI and academic performance. We also evaluated the impacts of other related risk factors, including the age, WC, dietary habits, physical activity, method of transportation to/from the school, type of school, parent's education, parents working status, living situation, sleeping patterns, and smoking.

Data analysis. Data were collected and analyzed using the Statistical Package for the Social Sciences (IBM Corp., Armonk, NY, USA) version 20. Frequencies and percentages were used for each variable; The Chi squared test was used to study the relationship between variables and the T-test was used to compare between means. Post hoc 1-way-analysis of variance (ANOVA) were used to assess the relation between all BMI categories groups and subject sciences. Partial correlation analysis was used to determine the degree of association between BMI and academic performance. Study proposal was approved by Taif University School of Medicine Ethical Committee.

Results. A total of 424 students were enrolled in the study with a mean age of 15.44 years, mainly male, 53.8% were high school students and most of them attended public schools (**Table 1**). The mean BMI of 22.26 kg/m², 43.5% of the students were considered to have normal weight, 24.5 either overweight or obese. The mean overall GPA for all subjects is 82.44% with 44.9% of the students obtained an excellent grade in the overall grade. The mean GPA for the science subjects (Biology, Physics, Chemistry, and Math) is 70.91%, the highest results mean was obtained in the physics subject, while the lowest were in math. Most of them live with both parents, own their houses, with one or both parents working. Only 39.5% report optimal sleep hours per night, 41.9% takes regular naps, but only 21.1% of them takes the recommended nap time (less than 30 min).[15] While most of them eat their breakfast

regularly and report eating their lunch and dinner with their family. 34.8% report a sedentary lifestyle 27.7% reported that they walked to and from school daily. Also 45.2 % considered to have high (excellent) academic performance group (**Table 2**). Students who achieved excellent academic performance tend to be taller, more likely to attend private school, and live with well-educated parents (Bachelor degree or higher education level). They also have higher rates of optimal sleeping hours per nights and seldom eat out. The BMI, WC, physical inactivity, and dietary habits appeared to be non-significantly different between the groups.

When the academic performance groups were

Table 1 - Baseline characteristics of the whole cohort.

Baseline characteristics	Frequency
Baseline characteristics	
Mean age (yrs) (mean±SD)	15.44±1.5
Male (%)	74.8
High school students (%)	53.8
Study at governmental school (%)	83.7
Mean BMI (Kg/m²) (mean±SD)	22.26±5.81
Mean waist circumference (cm)	82.09±14.84
Academic performance (%)	
Students with excellent overall grade	44.9
Mean GPA for all subjects	82.44
Mean GPA for subject science	70.91
Mean biology results	74.05
Mean chemistry results	81.1
Mean physic results	83.92
Mean math results	63.24
Socioeconomic (%)	
Live with both parents	89.5
Own their houses	58.9
Both parents work	24.1
Low level of education (father)	50.8
Low level of education (mother)	61
Sleep habits (%)	
Optimal sleep hrs	39.5
Regular nap	41.9
Diet habits (%)	
Eat their breakfast at home	36.8
Eat their breakfast regularly	63
Eat lunch with family	86.3
Eat dinner with family	83.4
At least eat once daily from outside	26.2
Eat fruits at least once daily	17.2
Eat vegetable at least once daily	21.5
Physical activity (%)	
Sedentary life style	34.8
Smoking(%)	
Active smoker	6.5

BMI - Body mass index, SD - standard deviation, GPA - Grade point average

divided based on their BMI; the differences between the mean of overall GPA and the GPA between the groups of science subjects were not statistically significant (Table 3). However, the Post hoc 1-way-ANOVA shows significant interaction between obese and normal weight students, with obese students performing worse than normal weight student in physics results (p=0.049). Partial correlation adjusting for the type of school, living status, parents working and educational status, sleeping and dietary habits, physical activity, smoking,

Table 2 - Baseline characteristics based on overall Grade point average.

Characteristics	Groups		
	>90	<90	*P*-value
Baseline characteristic			
Overall students in this group *(%)*	45.2	54.8	
Age (years)	15.66 +1.28	15.41±1.24	0.002
Male (%)	84.8	88.4	0.7
Students attend private school *(%)*	40.9%	20.1%	<0.05
Weight (kg)	63.85±19.69	59.1±18.0	0.049
Height (meter)	1.67±0.09	1.62±0.09	<0.05
BMI (kg/m^2)	22.75 ±5.4	22.4±6.0	0.67
Waist circumference (cm)	83.31±14.7	81.98±14.58	0.55
Academic performance (mean±SD)			
Mean GPA for science	90.73±7.0	69.0±15.34	<0.05
Math	88.87±10.0	54.25±27.68	<0.05
Biology	91.9±6.8	73.82±18.15	<0.05
Chemistry	94.4±7.13	86.4±11.5	<0.05
Physics	96.4±4.2	89.9±10.4	<0.05
Socioeconomic (%)			
Living with both parent	94.1	83.5	0.013
Father with college or higher degree	62.6	41.4	0.037
Mother with college or higher degree	57.4	34.2	0.009
Both parent works	31.6	22.73	0.66
Special and dietary habits (%)			
Optimal sleeping hours	56.7	27.0	<0.05
Regular nap	37.6	43.3	0.58
Eat breakfast daily	64.1	67.4	0.71
Eating breakfast at home	37.0	39.5	0.07
Rarely eating from outside (weekly or less)	82.9	56.6	<0.05
Eating fruits daily	14.4	21.3	0.01
Eating vegetables daily	21.2	23.6	0.13
Sedentary life style	32.04	38.6	0.79
Active smoker	2.9	7.1	0.057

>90= high excellent group, <90= low academic group, BMI - ¿ody mass index, SD - standard deviation.

Table 3 - The mean overall GPA/science subject and GPA/ mean results of subject science (math, physics, chemistry, and biology) according to BMI categories.

Variables	Under weight	Normal weight	Overweight	Obese	*P*-value
Number of students (%)	123/29%	197/46.5%	61/14.4	43/10.1%	
Mean BMI	16.58±1.34	21.56±1.97	27.09±1.57	34.8±4.51	<0.05
Overall GPA	80.95±11.9	84.1±12.27	80.12±13.49	82.5±12.9	0.21
Calculated science GPA	71.1±20.17	70.5±25.65	70.33±20.7	73.2±17.68	0.92
Math	64.7±24.9	62.25±31.9	61.45±26.97	66.6±24.1	0.75
Biology	73.8±21.9	73.33±27.72	74.2±23.0	77.5±19.1	0.81
Chemistry	78.5±17.99	84.3±16.19	77.85±20.10	76.5±16.4	0.095
Physics	81.2±18.7	86.97±15.25	81.6±16.3	79.1±15.2	0.091

Values are expressed as mean±standard deviation, GPA - grade point average, BMI - body mass index.

BMI, and WC showed a significant positive correlation between eating breakfast at home and the overall GPA.

Discussion. Our findings showed that students who achieved >90% in the overall GPA have a mean BMI mean±standard deviation=22.75±5.4 and those who achieved <90% in the overall GPA have a BMI of mean±SD=22.4±6.0, thus, showing that there is no significant differences between being overweight, obese, normal weight, or underweight. On the other hand, students who were obese achieved poor result in physics. Some studies have demonstrated that cognitive ability is influenced by obesity and the likelihood of being obese is influenced by the quality of nutrition (as the quality of nutrition decreases, the chance of obesity increases), so poor nutrition is associated with poor academic performance.[16] In contrast, not all studies have found a positive association between BMI and academic performance; some studies suggest that there is no relationship and others show an inverse relationship.[17,18] Our study didn't have family income information, but indirectly we were able to assess this relationship when evaluating the school type and parent's education. Our findings revealed that students who live with both parents and those with one or both parents having a college degree or higher were more expected to get 'excellent' in the overall grade. Previous studies showed a positive correlation between family income and academic achievements.[19] Our study also puts an emphasis on the importance of sleeping patterns on overall academic achievements. We showed that those who achieved >90 in the overall GPA were significantly more likely to reports optimal sleeping hours per night. One study confirmed this finding; they showed poor academic achievement strongly linked with short sleep duration that correlated with somnolence, which leads to reduce attention.[20] Our study demonstrates that no correlation exists between consuming fast food and academic performance, but other studies have shown that having too much junk food and an unhealthy diet decreases academic performance by limiting the amount of information to the brain.[3]

Our study's strengths include the evaluation of the factors that may affect academic performance and changes in BMI, which includes socioeconomic status, diet habits, sleeping habits, and physical activity. The weakness includes small sample size, only one city included, and an inability to precisely assess the socioeconomic state such as household income for students. Larger studies with a multicity approach and including rural areas are needed. Additional information should include school-based reference for students about the type of food sold at school, data regarding absent days of students with intervention approach. These data are needed to establish the causality and the associations, and to evaluate the weight for each of the possible risk factors that may have had a correlation if we had a larger sample size.

In conclusion there was no correlation between BMI, waist circumference, and school performance except in physics results, where obese students perform worse than normal-weight students. Students who achieved excellence in the overall grade are more likely to attend private school live with well-educated parents, getting optimal sleep hours per nights, and they seldom eat outside the home.

References

1. World Health Organization. Obesity and overweight: 2016 update. Geneva (GH): WHO; [date of access: May 2016]. Available From: http://www.who.int/mediacentre/factsheets/fs311/en/
2. Al-Hazzaa HM, Abahussain NA, Al-Sobayel HI, Qahwaji DM, Alsulaiman, NA, Musaiger AO. Prevalence of Overweight, Obesity, and Abdominal Obesity among Urban Saudi Adolescents: Gender and Regional Variations. *J Health Popul Nutr* 2014; 32: 634-645.
3. Tobin KJ. Fast-food consumption and educational test scores in the USA. *Child Care Health Dev* 2013; 39: 118-124.
4. Kleinman RE, Hall S, Green H, Korzec-Ramirez D, Patton K, Pagano ME, et al. Diet, breakfast, and academic performance in children. *Ann Nutr Metab* 2002; 46: 24-30.
5. Naticchioni, K. (2013). The Relationship between Obesity and Academic Achievement of School-Age Children.
6. Calzada PJ, Anderson-Worts P. The obesity epidemic: Are minority individuals equally affected? *Prim Care* 2009; 36: 307-317.
7. Aguirre-Pérez DM, Otero-Ojeda GA, Pliego-Rivero FB, Ferreira-Martínez AA. Relationship of working memory and EEG to academic performance: A study among high school students. *Int J Neurosci* 2007; 117: 869-882.
8. Kim JH, So WY. Association between overweight/obesity and academic performance in South Korean adolescents. *Cent Eur J Public Health* 2013; 21: 179-183.
9. Perez-Lloret, S., Videla, A. J., Richaudeau, A., Vigo, D., Rossi, M., Cardinali, D. P., & Perez-Chada, D. (2013). A multi-step pathway connecting short sleep duration to daytime somnolence, reduced attention, and poor academic performance: an exploratory cross-sectional study in teenagers. *JJ Clin Sleep Med* 2013; 9: 469-473.
10. Geier AB, Foster GD, Womble LG, McLaughlin J, Borradaile KE, Nachmani J, et al. The relationship between relative weight and school attendance among elementary schoolchildren. *Obesity (Silver Spring)* 2007; 15: 2157-2161.
11. Eisenberg ME, Aalsma MC. Bullying and peer victimization: position paper of the Societyfor Adolescent Medicine. *J Adolesc Health* 2005; 36: 88-91.
12. World Health Organization. Body mass index - BMI [June 2016] Available From: http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi

13. Australia's Physical Activity and Sedentary Behavior Guidelines. *Australian Government, Department of Health* 2014. [Updated 2014 July 10]. Available From: http://www.health.gov.au/internet/main/publishing.nsf/content/health-pubhlth-strateg-phys-act-guidelines#apa1317

14. Watson NF, Badr MS, Belenky G, Bliwise DL, Buxton OM, Buysse D, et al. "Recommended amount of sleep for a healthy adult: a joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society." *Sleep* 2015; 38: 843-844.

15. Takahashi M, Fukuda H, Arito H. "Brief naps during post-lunch rest: effects on alertness, performance, and autonomic balance." *Eur J Appl Physiol Occup Physiol* 1998; 78: 93-98.

16. Bradley, Beverly J., and Amy C. Greene. "Do health and education agencies in the United States share responsibility for academic achievement and health? A review of 25 years of evidence about the relationship of adolescents' academic achievement and health behaviors." *J Adolesc Health* 52; 5: 523-532.

17. Taras, H, Potts-Datema W. Obesity and student performance at school. *J Sch Health* 2005; 75: 291-295.

18. Baxter SD, Guinn CH, Tebbs JM, Royer JA. There is no relationship between academic achievement and body mass index among fourth-grade, predominantly African-American children. *J Acad Nutr Diet* 2013; 113: 551-557.

19. Bradley BJ, Greene AC. "Do health and education agencies in the United States share responsibility for academic achievement and health? A review of 25 years of evidence about the relationship of adolescents' academic achievement and health behaviors." *J Adolesc Health* 2013; 52: 523-532.

20. Perez-Lloret S, Videla AJ, Richaudeau A, Vigo D, Rossi M, Cardinali DP, et al. A multi-step pathway connecting short sleep duration to daytime somnolence, reduced attention, and poor academic performance: an exploratory cross-sectional study in teenagers. *J Clin Sleep Med* 2013; 9: 469-473.