The association between body mass index and academic performance

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ABSTRACT

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Objective: 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.

Result: A total of 14 schools included 424 students. 24.5% were either overweight or obese. The mean age was 15.44 years, 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.

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Related risk factors including dietary habits, activity, parent’s education, sleeping pattern, and smoking were recorded.

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

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C hildhood 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. 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. Although children who are overweight achieved poor result on math and reading tests when compared with their normal-weight peers. 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. 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). Academic performance is generally considered to be related to cognitive and memory functions. 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. 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. 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. 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). 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. 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

Disclosure. Authors have no conflict of interest, and the work was not supported or funded by any drug company.
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. 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. 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, parent’s 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). 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

| Baseline characteristics | Frequency |
|--------------------------|-----------|
| 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 |
| 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 physics results | 83.92 |
| Mean math results | 63.24 |
| 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 |
| Optimal sleep hrs | 39.5 |
| Regular nap | 41.9 |
| 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 |
| Sedentary life style | 34.8 |
| Active smoker | 6.5 |

BMI - Body mass index, SD - standard deviation, GPA - Grade point average
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students, with obese students performing worse than 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               | >90   | <90   | P-value |
|-------------------------------|-------|-------|---------|
| 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/m²)                   | 22.75±5.4 | 22.4±6.0  | 0.67    |
| Waist circumference (cm)      | 83.31±14.7 | 81.98±14.58 | 0.55   |

### 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. 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. 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. 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. 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.

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.

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**Statistics**

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Describe statistical methods with enough detail to enable a knowledgeable reader with access to the original data to verify the reported results. When possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Avoid relying solely on statistical hypothesis testing, such as the use of P values, which fails to convey important information about effect size. References for the design of the study and statistical methods should be to standard works when possible (with pages stated). Define statistical terms, abbreviations, and most symbols. Specify the computer software used.