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ABSTRACT The aim of this study was to evaluate the association between overweight/obesity and future academic performance among high-school students in Saudi Arabia. This was a retrospective cohort study of 257 12th grade female students in Alabna (Ministry of Defence) high schools in Riyadh during 2013/14. Overweight/obesity was based on weight and height at 10th grade. Decline in academic performance was defined as a reduction by > 1 standard deviation in marks between 10th and 12th grades. One hundred and five students were overweight/obese and 30 had declined academic performance. Self-esteem scale was similar in both groups. In a multiple logistic regression model adjusted for sociodemographic characteristics, study-related lifestyle and self-esteem, overweight/obesity was associated with declining academic performance. Other independent associates included paternal and maternal

education, and living outside governmentally provided housing. We report a negative independent association between overweight/obesity and subsequent academic performance among female high-school students in Saudi Arabia. The results highlight the need for community and school programmes to target overweight/obesity among high-school students.

Association du surpoids et de l'obésité avec la baisse des performances scolaires de lycéennes à Riyad (Arabie saoudite)

RÉSUMÉ La présente étude avait pour objectif d'évaluer l'association entre le surpoids/l'obésité et les futures performances scolaires de lycéennes en Arabie saoudite. Il s'agissait d'une étude de cohorte rétrospective incluant 257 lycéennes de douzième (classe terminale) au lycée Alabna (Ministère de la Défense) à Riyad entre 2013 et 2014. Le surpoids/l'obésité reposait sur le poids et la taille en classe de dixième (première classe du lycée). La baisse des performances scolaires a été définie comme une réduction de plus d'un écart type dans les notes entre la dixième et la douzième. Cent cinq lycéennes étaient en surpoids ou obèses, et 30 présentaient une baisse des performances scolaires. L'échelle d'estime de soi était similaire dans les deux groupes. Dans un modèle de régression logistique multiple ajusté en fonction des caractéristiques socio-démographiques, du mode de vie et de l'estime dans les études, le surpoids/l'obésité était associé(e) à une baisse des performances scolaires. D'autres éléments associés incluaient l'éducation paternelle et maternelle, et le fait de ne pas disposer d'un logement fourni par l'État. Nous avons rapporté une association indépendante négative entre le surpoids/l'obésité et les performances scolaires ultérieures des lycéennes en Arabie saoudite. Les résultats soulignent le besoin de programmes communautaires et scolaires pour cibler le surpoids/l'obésité parmi les lycéennes.

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Introduction

Over the last few decades, there has been a worldwide increase in childhood obesity affecting developed and developing countries (1). In the United States of America, the prevalence of obesity among adolescents aged 12–19 years increased from 5% in 1980 to nearly 21% in 2012 (2,3). In Saudi Arabia, several local and national reports have shown a similar problem,

with the prevalence of overweight and obesity among adolescent children ranging between 30% and 46% (4-6). As childhood obesity is likely to continue into adulthood, it puts the affected children at higher risk of obesity-related disorders such as diabetes and cardiovascular, respiratory, gastrointestinal and orthopaedic diseases at a younger age (7). Additionally, childhood obesity and associated distorted perception of body image can have a serious negative impact on child psychology, self-esteem and quality of life (8–10).

Several studies have examined the association between overweight/obesity and academic performance among students at different grades of elementary education, with conflicting findings. For example, several studies reported reduced academic performance in obese children (11–14), while other studies among primary school students failed to detect such an association (15–17). Additionally, gender-specific variability in the relationship between overweight/obesity and academic performance has been reported. Obese girls had lower academic achievement compared with those of a healthy weight. However, such an association was less clear in boys (12). In Chinese adolescents, overweight perception was related to lower GPA in girls only (8).

There is a poor understanding of the underlying mechanisms (14,18,19).

Despite the high prevalence of childhood/adolescent obesity and the importance of academic performance of high-school students in shaping their future education (20,21), there has been a lack of studies of the association between overweight/obesity and academic performance among Saudi Arabian students. The objective of the current study was to evaluate the association between overweight/obesity and future overall academic performance among high-school students in Saudi Arabia.

Methods

Setting

The current study was conducted at the Alabna (Ministry of Defence) high schools, which include 5 female schools, located in Riyadh, Saudi Arabia. As these schools are exclusively serving children of employees in the Ministry of Defence, the schools are jointly managed by the Ministry of Education and Ministry of Defence. The female schools served 1289 high-school students in 2014, with 384 students in the 12th grade.

Study design

This was a retrospective cohort study. We obtained all required ethical approvals from the

Institutional Review Board (IRB) of King Saud University and IRB of Prince Sultan Military Medical City.

Study population

The study was carried among 12th grade students during the 2013/14 academic year. Potential candidates for the study were all students who had mid-year marks for the 12th grade (2013/14), final year marks for the 10th grade (2011/12), and 10th grade height and weight measurements. We excluded students whose guardians refused to give consent, those with chronic diseases, and those who did not complete the study questionnaire.

Sample size

As shown in previous studies in Saudi Arabia (4–6), we assumed that the ratio of normal weight to overweight/obesity among the students would be 2: 1. As per the study definition, the decline in academic performance (> 1 standard deviation; SD) was expected at a prevalence of ~16%, assuming a normal distribution. It was estimated that at least 260 students were required to detect a 15% difference in academic decline between the two study groups (10% vs 25%), at 95% confidence level and 90% power.

Exposure definition

Overweight/obesity was based on body mass index (BMI) calculated from weight (kg) and height (cm) measurements obtained from students' school health medical records or records in Riyadh Military Hospital databases during the 10th grade (2011/12). The cutoff point for overweight/obesity was the 85% percentile based on the 2000 Centers for Disease Control and Prevention BMI-for-age percentiles charts. This was equivalent to 24.6 for female students aged 16 years.

Outcome definition

Decline in academic performance was defined as a > 1 SD reduction between mid-year marks at 12th grade (2013/14) and final year marks at 10th grade (2011/12), to allow better comparisons of relative changes across tests (22). The students' marks were obtained from official school records after obtaining permission from the Ministry of Education and students' guardians. The marks of the 10th and 12th grades were chosen to outline the beginning and end of the high-school years. Mid-year rather than final marks of the 12th grade were chosen to improve the response rate, as recruiting students outside the school during the summer vacation would have been difficult.

Questionnaire

We developed and administered a self-administrated questionnaire to all students. The students were asked to answer questions about socioeconomic factors and study-related lifestyle habits such as watching television (number of hours), internet and computer use (yes/no), study room availability and adequacy (yes/no), and current smoking (yes/no). Self-esteem was assessed using the 10-item Rosenberg Self-Esteem Scale, which was answered using a 4-point Likert scale ranging from strongly agree to strongly disagree (23). The scale items were translated into Arabic and back translated to English to detect any variability.

Recruitment

Students whose guardians agreed to study participation were asked to complete the study questionnaire. This was done during field visits to each school and the questionnaires were completed under supervision of the researcher, to respond to any inquiry and improve the quality of data. The response rate was 83.1% (310/373).

Statistical analysis

Data are presented using frequencies and percentages for categorical data and mean (SD) for continuous data. Significant differences in sociodemographic characteristics, study-related lifestyle habits and self-esteem among overweight/obese and other students were evaluated using the X 2 or Fisher's exact test for categorical data and Student's t test or Mann–Whitney U test for continuous data. Decline in academic performance was compared between the two study groups. To detect independent associations between student characteristics (including overweight/obesity status) and the decline in academic performance, multiple logistic regression models were run, using backward elimination. The confidentiality of data was assured through anonymous analysis of coded questionnaires and allowing access to data only for researchers and for the purposes stated in the signed consent. All P values were 2-tailed. $P < 0.05$ was considered to be significant. SPSS version 20.0 (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses.

Results

Out of 373 female students of Alabna high schools who had 12th grade marks available, 33 (8.8%) were missing the 10th grade marks. Out of the 340 high-school students who had 10th and 12th grade marks available, 25 (7.4%) did not have 10th grade BMI measurements and 63 (18.5%) did not complete the study questionnaire. This left 257 students for the current analysis. The average BMI was 23.2 ± 5.7. Female growth charts showed that 105 (40.9%) out of the 257 students were either overweight (53, 20.6%) or obese (52, 20.2%).

Table 1 shows the sociodemographic characteristics of the students. The majority (251, 97.7%) were living with both parents with an average family size of 6.1 ± 2.4 individuals. Most

(170, 67.5%) fathers were aged ≥ 45 years, whereas most (201, 78.5%) mothers were aged < 45 years. One hundred and four (41.3%) fathers and 69 (27.3%) mothers had college or graduate education, whereas 53 (21.0%) fathers and 127 (50.2%) mothers had less than secondary education. One hundred and ninety (75.7%) fathers were working in military occupations, with 78 (30.5%) as officers and 115 (44.9%) not as officers. Only 53 (20.7%) mothers were working and the rest were housewives. One hundred and forty-one (55.7%) students were living in governmentally provided housing facilities.

As shown in Table 2, 154 (60.2%) students had a designated non-noisy place for studying. Two hundred and thirty (89.8%) had their own computer and 244 (96.1%) had internet access. On average, the students were watching television for 2.3 ± 1.6 hours per day. Only one (0.4%) student reported smoking. Out of a maximum 30 points, the average self-esteem scale was 20.6 ± 4.0 points. The average marks (per 100) were 86.5 ± 9.7 for 10th grade and 89.5 ± 9.2 for 12th grade, with an average improvement of 3.1 ± 6.6 marks. Using standardized difference (12th minus 10th grade marks), 30 students (11.7%) had declined academic performance (< 1 SD) and 227 (88.3%) had constant or improved academic performance (> 1 SD) (Figure 1).

Comparing student characteristics by overweight/obesity status (Tables 1 and 2), only having an older (> 55 years) father (P = 0.009), prolonged television watching (P = 0.038), and to a lesser extent, living in non-governmentally provided housing (P = 0.053) were associated with being overweight or obese in the 10th grade. Self-esteem scale points were similar in both groups (20.5 ± 4.0 vs 20.8 ± 4.0, P = 0.921). The decline in academic performance according to overweight/obesity status is shown in Figure 1. Overweight/obese students had a significantly greater decline in academic performance as compared with their nonoverweight peers (18.1% vs 7.2%, P = 0.023).

The results of multiple logistic regression models that were adjusted for all the above student characteristics (sociodemographic characteristics, study-related lifestyle habits, and self-esteem) are shown in Table 3. Being overweight/obese was associated with a higher decline in academic performance (odds ratio = 3.73, 95% confidence interval = 1.30–10.74, P = 0.015) even after adjusting for the above characteristics. Additionally, having a father with low (secondary) education (P = 0.014) and living outside the governmentally provided housing (P = 0.008 for owned and P = 0.003 for rented housing) were independently associated with greater decline in academic performance. In contrast, having a mother with less than secondary education was independently associated with lesser decline in academic performance (P = 0.039).

Discussion

We reported a negative association between overweight/obesity and subsequent (2-year) academic performance measured among a sample of female high-school students in Saudi Arabia. This is in accordance with the majority of previous studies. For example, in a recent longitudinal study in the United Kingdom of Great Britain and Northern Ireland, obese students at age 11 years had reduced subsequent academic performance measured 5 years later compared with those of a healthy weight (12). Similarly, the negative association between overweight/obesity and concurrent academic performance was seen in several cross-sectional studies (13,14,24), including some with female students only (8,12). For example, perceived overweight among Chinese adolescents was associated with low self-reported grade point average (GPA) in female but not male students (8). In contrast, several studies conducted among primary-school students in different parts of the world failed to detect an association between overweight/obesity and concurrent academic performance (15–17). This failure was attributed to level of adjustment for confounding variables, especially socioeconomic and psychosocial factors, differences in the analytical techniques used, and differences in the age or ethnicity of the study samples (15,16).

Several explanations have been suggested for the negative association between BMI and academic performance. These include higher rates of health-related school absenteeism (25), reduced cognitive function (26), negative impact on self-esteem (9), concurrent depressive symptoms (8), and finally, peer and teacher prejudice (14,18). However, such a negative association was shown in previous studies to be independent of depressive symptoms, intelligence quotient (IQ) and several sociodemographic characteristics (12, 13). Additionally, the negative association between overweight/obesity and academic performance in the current study was independent of level of self-esteem and several potential sociodemographic and lifestyle confounders. The independent effect of paternal and maternal education and type housing on academic performance in the current study indicates that decline in academic performance is a multifactorial problem, with overweight/obesity playing a major role.

The significant negative impact of overweight/obesity on future academic performance may need to be confirmed in both genders and in schools in different parts of Saudi Arabia before the findings can be confidently generalized to average Saudi Arabian students. However, high prevalence of overweight/obesity (40%) and the suggested negative impact on academic performance shown in the current study may confirm the need for community and school programmes targeting overweight/obesity by encouraging physical activity and healthy eating among Saudi Arabian high-school students (27). Additionally, the current findings may provide parents and adolescents with greater motivation to engage with initiatives to prevent childhood obesity (12).

The current study had many advantages, such as filling the local knowledge gap in an adolescent population with high prevalence of overweight/obesity. The prospective design

helped to suggest the causality between overweight/obesity and subsequent academic performance. The use of documented BMI and academic marks removed the impact of recall and self-perception biases. Nevertheless, we acknowledge several limitations. The study included only female students of military personnel in one city, therefore, the results should be generalized with caution to Saudi Arabian high-school students. Lack of data on some related factors such as absenteeism, IQ, psychological problems and physical activity may have limited our ability to adjust fully for possible confounding. Although we planned to include both genders, only data of female students were included in the current analysis to avoid selection bias caused by the low response rate among male students.

In conclusion, we report a negative independent association between BMI and subsequent academic performance among female high-school students in Saudi Arabia. The current findings highlight the need for community and school programmes targeting overweight/obesity among high-school students.

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