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# Overweight and obesity among adolescents in Saudi Arabia: a multi-school cross-sectional study

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## Abstract

**Background** Obesity in adolescence may track into adulthood. Understanding the multifactorial nature of obesity is necessary to curb the growing trends. This study aimed to provide updated estimates on the prevalence of overweight and obesity among adolescents and to scrutinize the associations with parental weight status and various lifestyle and socioeconomic factors.

**Methods** For this cross-sectional study, participants were recruited from 16 schools located in Jeddah and Madina, Saudi Arabia. Data of 522 adolescents (11–18 years of age) and their parents were collected through self-administered questionnaires. Anthropometric measurements of adolescents were assessed at the school sites. Logistic regression with complex sampling adjustments was conducted to examine the associations of adolescent overweight or obesity with various lifestyle and socioeconomic factors and parental weight status.

**Results** Overweight and obesity was prevalent by 13.2% and 26.1%, respectively. Living in a single-parent household, maternal obesity, and the coexistence of parental obesity were associated with an increased likelihood of overweight or obesity in adolescents. Stratified analyses by adolescent sex revealed different associations for boys and girls.

**Conclusions** Our findings highlight the importance of the family environment and the necessity to enroll parents when implementing adolescence obesity prevention programs. Health promotion strategies that promote environmental changes related to healthy lifestyle and dietary practices are needed to eliminate the rising obesity trends.

**Keywords** Prevalence, Overweight, Pediatric obesity, Adolescent, Parents, Lifestyle

## Introduction

The prevalence of overweight and obesity among the pediatric population has increased dramatically over the past five decades [1]. The World Health Organization (WHO) estimated that over 340 million children and adolescents are experiencing overweight or obesity [2]. A significant increase in the prevalence of obesity has been predicted; 206 million children and adolescents will be living with obesity in 2025, and additional 48 million children and adolescents will be obese in 2030 [3]. High prevalence of obesity (> 20%) has been also reported in a number of Middle Eastern countries and many other countries in North Africa and North America [1]. In Saudi Arabia, a prevalence of overweight and obesity among adolescents in 2015 has been estimated using the growth standards of the WHO as 18.9% [4]. A more recent study conducted between 2016 and 2021 using the Saudi growth standards estimated the prevalence of overweight and obesity among adolescents as 12.8% and 9.50%, respectively [5].

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Obesity in childhood and adolescence may track into adulthood [6] and is often associated with several health-related complications later in life, such as type 2 diabetes [7], cardiovascular diseases [8], and some types of cancers [9]. Furthermore, the current data suggest that adolescents with obesity are more vulnerable to micronutrient deficiencies due to the consumption of low-quality diets [10], increased dietary requirements, and hormonal imbalance [11, 12], which may impair growth and immune function [13]. Excessive body weight has been also linked with the mental health status in adolescents. Adolescents with overweight tend to have less life satisfaction and poorer body image, and have higher likelihood of experiencing social isolation and bullying [14].

Adolescence is a stage of life characterized by physical and psychological development that significantly affect food choices and eating patterns [15]; they tend to express greater independence and social interaction with peers which may influence the selection of calorie-dense foods, e.g., fast-foods [15], and limit physical activity due to sedentary behaviors, such as use of video games and computers [16].

A bio-socioecological framework has been proposed to explain the etiology of obesity in adolescents, encompassing genetic, socioeconomic, and environmental determinants [17]. Some studies suggest that 40% of the genetic variation in bodyweight is attributed to inheritance [18]. Additionally, adolescent gender has been linked to differences in obesity prevalence, with higher rates observed among boys [5, 19]. These gender-related differences have been attributed to biological factors (e.g., distribution of body fat, resting energy expenditure levels, and energy requirements), environmental factors (e.g., ability to participate in certain physical activities), and factors related to culture and society (e.g., dietary concerns and body image) [20].

In addition to biological aspects, socioeconomic factors play a crucial role in adolescent obesity. The literature indicates higher prevalence of obesity among low-income communities in developed countries and high-income communities in developing countries [21]. Furthermore, a study conducted among Greek adolescents and their parents suggested a positive association between overweight and obesity among parents and their children, whereas childhood obesity was negatively associated with parental education level and age [22]. While these associations might vary across populations, they remain relatively understudied. Identifying risk factors and the associations with Ow/Ob among the adolescent population need to be further understood to develop evidence-based, tailored obesity intervention programs.

The family environment is also a significant contributor to obesity during childhood and adolescence. Factors such as the availability of unhealthy food at home, infrequent family meals, parental pressure to eat, and parental weight status have been positively linked with the weight status of adolescents [23]. Additionally, Campbell et al. reported positive associations between maternal intake of high-calorie drinks, sweet and savory snacks, and take-out food and adolescents' intake [24]. This suggests that adolescents' dietary patterns may be influenced by familial diets, which could indirectly contribute to obesity [20].

In this research, we aimed to evaluate the prevalence of overweight and obesity among the adolescent population using the WHO growth reference standards, and to evaluate the associations of adolescents' overweight and obesity with various socioeconomic and lifestyle factors and parental overweight and obesity status. We also addressed whether having single or both parents with overweight or obesity is associated with overweight or obesity (Ow/Ob) in adolescent in Saudi Arabia.

## Methods

### Study design

The present study targeted adolescents aged 11–18 years and their parents from 16 selected schools across Jeddah and Madinah cities, two major cities in the Western region of Saudi Arabia. Two schools were randomly selected from each area within each city (north, south, east, west), considering variations in neighborhood wealth to represent a range of socioeconomic backgrounds and lifestyles. Equal proportions of public and private schools were approached, with four public and four private schools selected per city.

A total of 2000 envelopes were distributed to adolescents between October and November 2021 in randomly selected classes across each grade level in the participating schools (125 envelops allocated to each school). In schools with only one class per grade, all students in that class received an envelope. Each envelope included a description of the study, a parental consent form, and a questionnaire to collect contact information and personal data (sociodemographic and anthropometric data of the parents). Dietary and anthropometric data were gathered at school sites from adolescents who returned the envelopes with the signed consent forms and completed questionnaires within two weeks of distribution. Individuals with food allergy or chronic diseases and those on dietary restriction (e.g., low-calorie diet or vegan diet) may have different nutritional needs and eating patterns that could influence their weight status [25–27]. Therefore, adolescents who reported positive food allergy or chronic diseases, were on dietary restrictions or on medication that

may affect weight status were excluded from the study. Participants who had incomplete anthropometric data were also excluded to eliminate biased conclusions.

Based on the sample size calculation conducted using G*Power (version 3.1.9.6, 2020) for a two-tailed binomial test, the required sample size to detect a medium effect size with an alpha level of 0.05 and a power of 0.80 is a minimum of 90 participants from each sex (90 boys and 90 girls).

Ethical approval was granted from the Ethics and Research Committee of the Faculty of Applied Medical Sciences at King Abdulaziz University (FAMS-EC2021 - 13). Parents of adolescents included in the study provided written informed consents for participation.

## Measures

### *Sociodemographic and lifestyle factors*

The envelops sent home to parents included a questionnaire to be completed by either the mother or the father, which included questions concerning adolescent's date of birth, sex (1 = boy; 2 = girl), and nationality (1 = Saudi; 2 = non-Saudi) and parental age, education level (1 = high school or less; 2 = college degree); 3 = postgraduate degree), employment status (1 = unemployed; 2 = employed), monthly household income in Saudi riyals (1 = less than 6,000; 2 = 6,000 to < 11,000; 3 = 11,000 to < 16,000; 4 = 16,000 to < 20,000; 5 = ≥ 20,000), and family type (1 = both parents; 2 = single parent).

Lifestyle information including diet quality, frequency of fast-food consumption per week, and screen time per day were collected from adolescents at the school sites. The diet quality of adolescents was assessed using the short-form food frequency questionnaire (SFFFQ), which has been modified and validated by two experts in the field to ensure that the typically consumed food items by adolescents in the Saudi community are included [28, 29]. The SFFFQ includes 20 items: 1) "Fruits"; 2) "Fruit juice"; 3) "Salad"; 4) "Cooked vegetables"; 5) "Fried potatoes/chips"; 6) "Beans or legumes"; 7) "Fiber-rich breakfast cereal"; 8) "Whole wheat bread"; 9) "Cheese/yoghurt"; 10) "Crisps/savory snacks"; 11) "Sweet biscuits"; 12) "Ice-cream/cream"; 13) "Fizzy drinks/pop" (Frequencies provided in the SFFFQ for these items were: Never or Rarely; < 1 time/week; 1 time/week; 2–3 times/week; 4–6 times/week; 1–2 times/day; 3–4 times/day; ≥ 5 times/day); 14) "Beef or lamb"; 15) "Chicken or turkey"; 16) "Processed meats/meet product"; 17) "Processed chicken/turkey"; 18) "Fried white fish"; 19) "White fish"; 20) "Oily fish" (frequencies provided in the SFFFQ for these items were: Never or Rarely; < 1 time/week; 1 time/week; 2–3 times/week; 4–6 times/week; ≥ 7 times/week). The data collectors distributed a hard copy of the SFFFQ in class and guided the adolescents during the process of collecting the data. Responses were later entered into an excel sheet that auto calculated the total score of the diet quality for each adolescent.

Adolescents were also requested to provide data concerning the average consumption of fast-food per week and average hours spent on screen per day. Data concerning the frequency of fast-food consumption were later categorized into two groups (≤ 2 times/week vs. > 2 times/week) [30–32]; data of screen time were categorized into two groups (≤ 2 h/day vs. > 2 h/day) [33]. After completing the dietary and lifestyle data and answering all questions, adolescents were asked to hand in the envelops with the SFFFQ and were directed to the next station to collect their anthropometric data.

### *Anthropometric measurements*

Adolescents' anthropometric measurements were assessed by trained healthcare professionals using a standardized protocol at the school sites [34]. Adolescents were asked to take off their shoes, remove any heavy clothes/sweaters, and empty all pockets before weight was measured. An electronic scale was used to measure the weight (in kg) of each adolescent rounded to the nearest 0.1 kg (OMRON BF508, Japan). Height of adolescents (in cm) was assessed using a measuring tape that was assembled into a straight wall. Adolescents were asked to look straight, and height was rounded to the nearest 0.5 cm. Weight of adolescents was measured twice; if the measurements varied by more than 0.1 kg, the weight was reassessed and the average of the three measurements was recorded. The body mass index (BMI) was then calculated as weight (in kg) divided by height (in m) squared ($kg/m^2$) and compared with the WHO sex- and age-specific BMI/age standards to define the weight status of adolescents as follows: underweight (BMI < 5 th percentile); healthy weight (BMI of 5 th to < 85 th percentiles); overweight (BMI of 85 th to < 95 th percentiles); and obesity (BMI ≥ 95 th percentiles) [35].

Self-reported weight and height were provided by parents. The BMI was calculated as weight (kg) divided by height ($m^2$). Parental weight status was classified as underweight (BMI < 18.5 $kg/m^2$), healthy weight (18.5 < BMI < 24.9 $kg/m^2$), overweight (BMI ≥ 25–29.9 $kg/m^2$), or obesity (BMI ≥ 30 $kg/m^2$) [36]. Under- and healthy-weight (U/HW) categories were collapsed into one category for the adolescents and parents given the limited prevalence of underweight among mothers (1.90%, $n = 10$) and fathers (0.80%, $n = 4$).

### *Statistical analysis*

Data were described using descriptive statistics. Chi-square test was used to investigate the associations

between adolescents' weight status and sociodemographic, lifestyle, and parental factors and to identify potential confounders. Two-sided tests were used, and the significant level was set at $\alpha = 0.05$. Post-hoc analysis with Bonferroni adjustment was performed to further explore the significant associations obtained by the chi-square test (Supplementary File 1).

Logistic regression with complex sampling adjustments was conducted to examine the association between adolescent Ow/Ob status (dependent variable) and various sociodemographic, lifestyle, and parental factors (independent variables) for the total adolescent sample and separately for boys and girls. Complex sampling adjustments were applied to account for the multistage sampling design, with city defined as the stratification variable, school as the clustering variable, and sample weights calculated for each school. The independent variables included adolescent sex (for the total sample) and age, nationality, screen time per day, fast-food consumption per week, dietary quality, parental age, education, and employment status, family income, family type, and parental weight status. Each independent variable was evaluated for its contribution to the likelihood of adolescents being with overweight or obesity (compared to healthy weight adolescents).

The likelihood of adolescents having Ow/Ob was also evaluated based on the coexistence of parental Ow/Ob (single parent/both parents) using similar models interchangeably. Odds ratios (ORs) with 95% confidence intervals (CI) were used to assess the associations. All analyses were conducted using SPSS 24.0 (IBM Corp., Armonk, NY, USA).

## Results

### Adolescents and parental characteristics

Thirty-seven percent of the envelopes were returned ($n = 741$). The final analyses included data of 522 adolescents (238 boys and 284 girls), after excluding adolescents with missing data, food allergies, chronic disease, adolescents on medications or diet restrictions, and adolescents > 18 years (Fig. 1). The mean age of the adolescents was 14.5 ± 1.80 years. The majority of the adolescents were Saudis (81.7%) and residing in dual-parent households (93.3%). Mean maternal and paternal ages were 42.3 ± 6.33 and 49.3 ± 7.39 years, respectively. Nearly one-third of the mothers and three-quarters of the fathers are employed (34.5% and 75.6%, respectively). Two-thirds of mothers and fathers had completed a college degree or higher (63.6% and 60.0%, respectively). Over one-third of the


**Fig. 1** Flowchart of study sample

families (37.8%) had a monthly household income of ≥16,000 Saudi riyals.

Characteristics of the sample according to adolescents' weight status are depicted in Table 1. In total, the prevalence of overweight and obesity among adolescents were 13.2% and 26.1%, respectively. The prevalence of overweight among boys and girls were 12.2% and 14.1%, respectively. Significantly higher prevalence of obesity was observed in adolescent boys (34.5%) compared to adolescent girls (19.0%).

Mean BMI for mothers and fathers were 26.1 ±4.40 and 27.8 ±4.86 kg/m$^2$, respectively. The prevalence of overweight and obesity were 35.1% and 20.1% among the mothers and 41.8% and 28.7% among the fathers. Overweight and obesity among both parents were prevalent by 14.4% ($n$ = 75) and 9.20% ($n$ = 48), respectively. The distribution of adolescents' weight status according to maternal and paternal weight status is depicted in Fig. 2. The prevalence of overweight among adolescents with one parent experiencing overweight was 11.3% ($n$ = 28), whereas 13.3% of adolescents ($n$ = 10) had overweight status when both parents were experiencing overweight. On the other hand, the prevalence of obesity was 28.3% ($n$ = 45) among adolescents with one parent experiencing obesity, whereas 39.6% of adolescents had obesity ($n$ = 19) when both parents were experiencing obesity.

#### Associations of adolescents' overweight/obesity status with sociodemographic, lifestyle, and parental factors

The association between adolescent Ow/Ob status (compared to U/HW status) and various sociodemographic, lifestyle, and parental factors was examined using a logistic regression model with complex sampling adjustments. For the total sample, results indicated significantly lower odds for Ow/Ob among Saudi adolescents compared to non-Saudis (Table 2). Furthermore, compared to adolescents residing in dual-parent households, those residing with a single-parent had significantly higher odds for Ow/Ob. Additionally, maternal obesity predicted higher odds for adolescent Ow/Ob compared to mothers with U/HW status. No association was observed between adolescent Ow/Ob status and paternal weight status or the other sociodemographic or lifestyle factors.

Stratified analyses by adolescent sex showed different associations for boys and girls. Boys from lower income families (< 6,000 Saudi riyals) had significantly lower odds for Ow/Ob compared to boys from higher income families (≥ 20,000 Saudi riyals). Additionally, the Saudi boys had a significantly lower odds for Ow/Ob compared to non-Saudi boys. On the other hand, maternal obesity status predicted higher odds for having daughters with Ow/Ob compared to maternal U/HW status, whereas no association was observed for adolescent boys.

#### Adolescents' and parental overweight/obesity status

We further investigated the likelihood of Ow/Ob among adolescents based on the co-existence of parental Ow/Ob (Table 3). Results indicated that having one parent with overweight is associated with lower odds for adolescents being with Ow/Ob compared to having none of the parents with overweight. The co-existence of parental overweight was not associated with adolescents' Ow/Ob status. On the other hand, the co-existence of parental obesity increased the odds for adolescent Ow/Ob compared to having none of the parents with obesity.

Stratified analyses by adolescent sex indicated that the co-existence of parental overweight increased the odds of Ow/Ob in boys. In contrast, having a single parent with overweight was associated with lower odds of Ow/Ob in girls, whereas the coexistence of parental obesity increased the odds of Ow/Ob in girls.

## Discussion

This study aimed to assess the prevalence of overweight and obesity among adolescents and investigate the association with various socioeconomic and lifestyle factors and parental weight status. Compared to non-Saudi adolescents, Saudi adolescents were less likely to have Ow/Ob. Adolescents residing in single-parent households had significantly higher odds of having Ow/Ob compared to those living in dual-parent households. Furthermore, maternal obesity and the coexistence of parental obesity increased the likelihood of Ow/Ob in adolescents. Nevertheless, classification analyses by adolescent sex suggested different associations for boys and girls.

Data of the present study indicate a high prevalence of obesity among adolescents, with a higher prevalence observed in boys than in girls. This predominance of obesity among boys has also been reported in a study conducted among Greek adolescents, wherein 41.3% of boys experienced obesity compared to 31.8% of girls [22]. Previous data of Saudi adolescents indicated risen rates of overweight and obesity in 2015 (18.9%), compared to data reported in 2004 (14.1%), wherein no significant difference was observed in the proportions of obesity between adolescent boys and girls [4]. However, findings of the present study are consistent with that reported by AlEnazi et al. wherein significantly higher prevalence of obesity has been reported among adolescent boys compared to adolescent girls (10.4% vs. 8.3%, respectively using the Saudi growth standards) [5]. It has been postulated that compared to boys, adolescent girls could be more concerned with body image. Thus, tend to reduce their body weight [22]. Other important aspects to consider include the greater consumption of fast-food and energy drinks (> 3 times/week) in adolescent boys compared to girls [37]. Together, these data indicate an urgent

**Table 1** Adolescent and parental characteristics (Row %)

| Characteristics | Total sample ($n = 522$) | | | | Boys ($n = 238$) | | | | Girls ($n = 284$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | U/HW ($n = 317$) | Overweight ($n = 69$) | Obesity ($n = 136$) | *P* | U/HW ($n = 127$) | Overweight ($n = 29$) | Obesity ($n = 82$) | *P* | U/HW ($n = 190$) | Overweight ($n = 40$) | Obesity ($n = 54$) | *P* |
| **Adolescent characteristics** | | | | | | | | | | | | |
| *Age in years* | | | | | | | | | | | | |
| 11–12 | 45 (51.1) | 11 (12.5) | 32 (36.4) | 0.022* | 19 (45.2) | 6 (14.3) | 17 (40.5) | 0.795 | 26 (56.5) | 5 (10.9) | 15 (32.6) | |
| 13–14 | 92 (55.1) | 27 (16.2) | 48 (28.7) | | 40 (51.3) | 11 (14.1) | 27 (34.6) | | 52 (58.4) | 16 (18.0) | 21 (23.6) | 0.015* |
| 15–16 | 115 (64.2) | 23 (12.8) | 41 (22.9) | | 48 (56.5) | 10 (11.8) | 27 (31.8) | | 67 (71.3) | 13 (13.8) | 14 (14.9) | |
| 17–18 | 65 (73.9) | 8 (9.10) | 15 (17.0) | | 20 (60.6) | 2 (6.10) | 11 (33.3) | | 45 (81.8) | 6 (10.9) | 4 (7.30) | |
| *Nationality* | | | | | | | | | | | | |
| Saudi | 269 (63.3) | 58 (13.6) | 98 (23.1) | 0.003* | 101 (55.5) | 25 (13.7) | 56 (30.8) | 0.082 | 168 (69.1) | 33 (13.6) | 42 (17.3) | 0.084 |
| Non-Saudi | 43 (48.3) | 10 (11.2) | 36 (40.4) | | 23 (45.1) | 4 (7.80) | 24 (47.1) | | 20 (52.6) | 6 (15.8) | 12 (31.6) | |
| *Screen time per day* | | | | | | | | | | | | |
| ≤ 2 h | 42 (60.9) | 8 (11.6) | 19 (27.5) | 0.892 | 26 (60.5) | 5 (11.6) | 12 (27.9) | 0.497 | 16 (61.5) | 3 (11.5) | 7 (26.9) | 0.538 |
| > 2 h | 269 (60.6) | 60 (13.5) | 115 (25.9) | | 96 (50.8) | 24 (12.7) | 69 (36.5) | | 173 (67.8) | 36 (14.1) | 46 (18.0) | |
| *Fast-food consumption per week* | | | | | | | | | | | | |
| ≤ 2 times | 209 (59.2) | 47 (13.3) | 97 (27.5) | 0.473 | 81 (52.9) | 19 (12.4) | 53 (34.6) | 0.940 | 128 (64.0) | 28 (14.0) | 44 (22.0) | 0.101 |
| > 2 times | 95 (65.1) | 17 (11.6) | 34 (23.3) | | 40 (54.1) | 8 (10.8) | 26 (35.1) | | 55 (76.4) | 9 (12.5) | 8 (11.1) | |
| *Diet quality* | | | | | | | | | | | | |
| Quartile 1 | 107 (66.5) | 23 (14.3) | 31 (19.3) | 0.258 | 39 (58.2) | 9 (13.4) | 19 (28.4) | 0.560 | 68 (72.3) | 14 (14.9) | 12 (12.8) | |
| Quartile 2 | 62 (54.9) | 17 (15.0) | 34 (30.1) | | 16 (40.0) | 6 (15.0) | 18 (45.0) | | 46 (63.0) | 11 (15.1) | 16 (21.9) | 0.617 |
| Quartile 3 | 77 (62.6) | 12 (9.80) | 34 (27.6) | | 34 (56.7) | 5 (8.30) | 21 (35.0) | | 43 (68.3) | 7 (11.1) | 13 (20.6) | |
| Quartile 4 | 71 (56.8) | 17 (13.6) | 37 (29.6) | | 38 (53.5) | 9 (12.7) | 24 (33.8) | | 33 (61.1) | 8 (14.8) | 13 (24.1) | |
| **Parental characteristics** | | | | | | | | | | | | |
| *Maternal age* | | | | | | | | | | | | |
| 28–40 years | 147 (60.5) | 31 (12.8) | 65 (26.7) | 0.562 | 63 (54.3) | 15 (12.9) | 38 (32.8) | 0.439 | 84 (66.1) | 16 (12.6) | 27 (21.3) | |
| 41–49 years | 119 (59.8) | 24 (12.1) | 56 (28.1) | | 47 (51.6) | 8 (8.80) | 36 (39.6) | | 72 (76.7) | 16 (14.8) | 20 (18.5) | 0.878 |
| ≥ 50 years | 51 (64.6) | 13 (16.5) | 15 (19.0) | | 17 (54.8) | 6 (19.4) | 8 (25.8) | | 34 (70.8) | 7 (14.6) | 7 (14.6) | |
| *Maternal education status* | | | | | | | | | | | | |
| ≤ High school | 118 (62.4) | 22 (11.6) | 49 (25.9) | 0.139 | 47 (58.0) | 6 (7.40) | 28 (34.6) | 0.249 | 71 (65.7) | 16 (14.8) | 21 (19.4) | |
| College degree | 171 (62.0) | 34 (12.3) | 71 (25.7) | | 65 (52.0) | 16 (12.8) | 44 (35.2) | | 106 (70.2) | 18 (11.9) | 27 (17.9) | 0.352 |
| Postgraduate degree | 26 (48.1) | 13 (24.1) | 15 (27.8) | | 14 (46.7) | 7 (23.3) | 9 (30.0) | | 12 (50.0) | 6 (25.0) | 6 (25.0) | |
| *Maternal employment status* | | | | | | | | | | | | |
| Unemployed | 202 (60.1) | 42 (12.5) | 92 (27.4) | 0.591 | 87 (53.0) | 18 (11.0) | 59 (36.0) | 0.592 | 115 (66.9) | 24 (14.0) | 33 (19.2) | 0.956 |
| Employed | 109 (61.6) | 26 (14.7) | 42 (23.7) | | 36 (51.4) | 11 (15.7) | 23 (32.9) | | 73 (68.2) | 15 (14.0) | 19 (17.8) | |
| *Paternal age* | | | | | | | | | | | | |

**Table 1** (continued)

| Characteristics | Total sample ($n = 522$) | | | | Boys ($n = 238$) | | | | Girls ($n = 284$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | U/HW ($n = 317$) | Overweight ($n = 69$) | Obesity ($n = 136$) | *P* | U/HW ($n = 127$) | Overweight ($n = 29$) | Obesity ($n = 82$) | *P* | U/HW ($n = 190$) | Overweight ($n = 40$) | Obesity ($n = 54$) | *P* |
| 28–40 years | 37 (61.7) | 6 (10.0) | 17 (28.3) | 0.130 | 19 (65.5) | 4 (13.8) | 6 (20.7) | 0.407 | 18 (58.1) | 2 (6.50) | 11 (35.5) | |
| 41–49 years | 130 (59.9) | 22 (10.1) | 65 (30.0) | | 54 (50.5) | 11 (10.3) | 42 (39.3) | | 76 (69.1) | 11 (10.0) | 23 (20.9) | 0.023* |
| ≥ 50 years | 149 (61.6) | 40 (16.5) | 53 (21.9) | | 53 (53.0) | 14 (14.0) | 33 (33.0) | | 96 (67.6) | 26 (18.3) | 20 (14.1) | |
| *Paternal education status* | | | | | | | | | | | | |
| ≤ High school | 129 (62.0) | 23 (11.1) | 56 (26.9) | 0.449 | 54 (56.8) | 12 (12.6) | 29 (30.5) | 0.715 | 75 (66.4) | 11 (9.70) | 27 (23.9) | |
| College degree | 141 (61.0) | 30 (13.0) | 60 (26.0) | | 51 (51.5) | 10 (10.1) | 38 (38.4) | | 90 (68.2) | 20 (15.2) | 22 (16.7) | 0.153 |
| Postgraduate degree | 46 (56.1) | 16 (19.5) | 20 (24.4) | | 22 (50.0) | 7 (15.9) | 15 (34.1) | | 24 (63.2) | 9 (23.7) | 5 (13.2) | |
| *Paternal employment status* | | | | | | | | | | | | |
| Unemployed | 74 (60.2) | 22 (17.9) | 27 (22.0) | 0.163 | 26 (52.0) | 8 (16.0) | 16 (32.0) | 0.660 | 48 (65.8) | 14 (19.2) | 11 (15.1) | 0.288 |
| Employed | 233 (61.0) | 45 (11.8) | 104 (27.2) | | 96 (52.5) | 21 (11.5) | 66 (36.1) | | 137 (68.8) | 24 (12.1) | 38 (19.1) | |
| *Household income in Saudi Riyals* | | | | | | | | | | | | |
| < 6,000 | 59 (56.2) | 10 (9.50) | 36 (34.3) | 0.054 | 34 (56.7) | 5 (8.30) | 21 (35.0) | 0.582 | 25 (55.6) | 5 (11.1) | 15 (33.3) | |
| 6,000 to < 11,000 | 74 (63.8) | 14 (12.1) | 28 (24.1) | | 27 (52.9) | 6 (11.8) | 18 (35.3) | | 47 (72.3) | 8 (12.3) | 10 (15.4) | |
| 11,000 to < 16,000 | 62 (63.3) | 18 (18.4) | 18 (18.4) | | 18 (54.5) | 6 (18.2) | 9 (27.3) | | 44 (67.7) | 12 (18.5) | 9 (13.8) | 0.225 |
| 16,000 to < 20,000 | 62 (67.4) | 7 (7.60) | 23 (25.0) | | 21 (58.3) | 2 (5.60) | 13 (36.1) | | 41 (73.2) | 5 (8.90) | 10 (17.9) | |
| ≥ 20,000 | 53 (52.0) | 18 (17.6) | 31 (30.4) | | 24 (43.6) | 10 (18.2) | 21 (38.2) | | 29 (61.7) | 8 (17.0) | 10 (21.3) | |
| *Family type* | | | | | | | | | | | | |
| Both parents | 292 (60.3) | 66 (13.6) | 126 (26.0) | 0.689 | 117 (52.9) | 27 (12.2) | 77 (34.8) | 0.988 | 175 (66.5) | 39 (14.8) | 49 (18.6) | 0.428 |
| Single parents | 22 (62.9) | 3 (8.60) | 10 (28.6) | | 8 (53.3) | 2 (13.3) | 5 (33.3) | | 14 (70.0) | 1 (5.00) | 5 (25.0) | |

* $P < 0.05$. Values are expressed as n (%)

U/HW, underweight/healthy weight

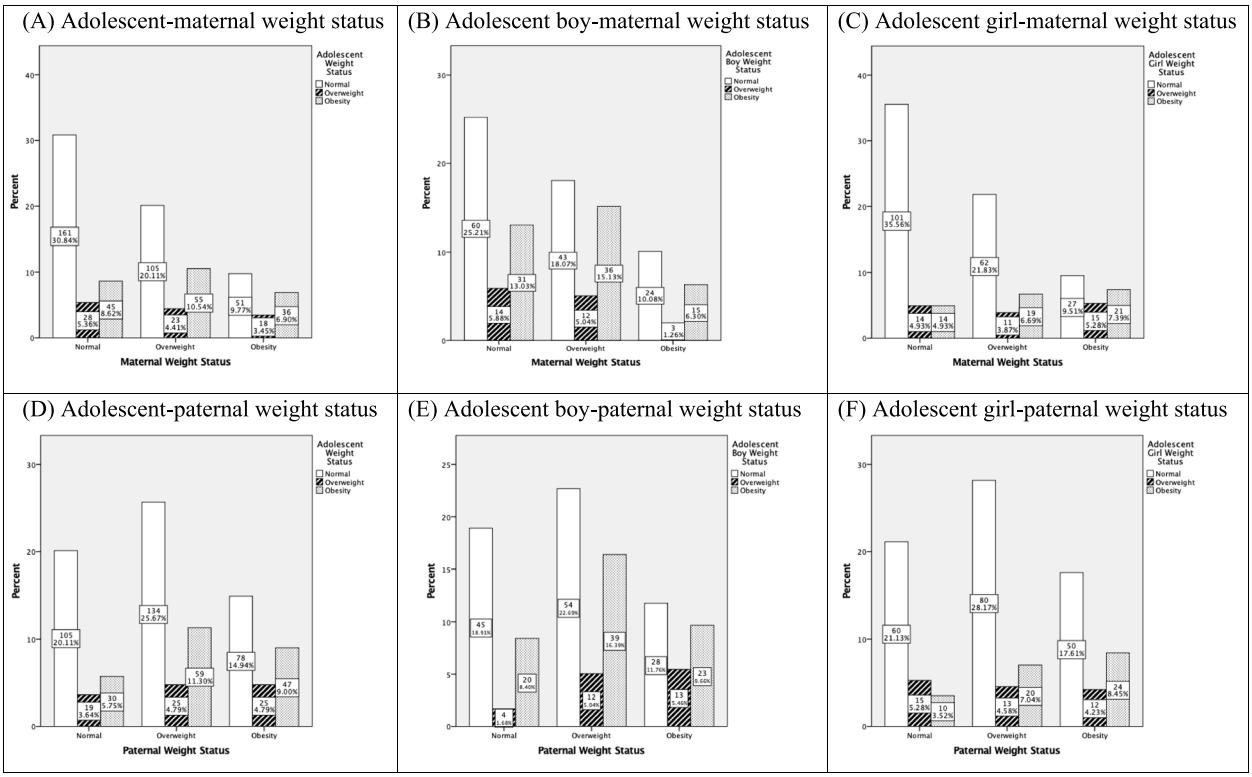


**Fig. 2** Weight status of adolescents in relation to parental weight status

need to design and implement effective obesity intervention programs aiming at promoting healthy eating and physical activity.

Interestingly, the present findings show that Saudi adolescents have a lower likelihood of having Ow/Ob compared to the non-Saudis, particularly among boys. Relevant data comparing the prevalence of Ow/Ob between Saudi and non-Saudi adolescents are lacking. A study conducted in Al-Qassim region reported healthier weight-related dietary behaviors among non-Saudi adolescents, i.e., less fast-food consumption, compared to Saudi adolescents [38]. However, the dietary behaviors are expected to vary across the study settings, particularly given the greater exposure to obesogenic urban lifestyle within the Western region compared to Al-Qassim region, a relatively less urbanized area. Future research should explore regional variations to better understand determinants of Ow/Ob in different settings.

Results from the current study have shown that compared to adolescent boys from high-income households, those from low-income households have less likelihood to experience Ow/Ob. Similar findings have been reported by studies conducted in Saudi Arabia [39–41]. Low-income families may have limited access to calorie-dense fast foods, which are more prevalent in high income households. Additionally, boys from low-income households may engage in more physically active lifestyles due to limited access to sedentary entertainment options, such as video gaming, which are more common in wealthier households.

The present data do not suggest an association between adolescents' weight status and screen time or diet quality. This finding might be explained by previous findings indicating widespread poor dietary practices and sedentary lifestyle among adolescents, which could potentially limit variability within the sample. Lifestyle practices of adolescents in Saudi Arabia have been characterized by excessive consumption of fast-food, sugar-sweetened beverages, and sweets, while having a limited intake of fruits and vegetables. Additionally, prolonged screen time, and physical inactivity are prevalent among this population [42]. To address the growing prevalence of overweight and obesity among adolescents, obesity intervention programs must be handled on multiple levels within the context of school system and family environment.

Previous studies have suggested that non-traditionally families, such as single-parent households, may influence children's well-being [43, 44]. In fact, results of the present study suggest that adolescents in single-parent

**Table 2** Associations of adolescents' overweight/obesity status with socioeconomic and lifestyle factors[a]

| Characteristics | Overweight/obesity to reference category | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total sample | | | Boys | | | Girls | | |
| | OR | 95% CI | | OR | 95% CI | | OR | 95% CI | |
| | | Lower | *Upper* | | Lower | *Upper* | | Lower | *Upper* |
| **Adolescent characteristics** | | | | | | | | | |
| *Sex* | | | | | | | | | |
| Boys | 1.00 [reference category] | | | N/A– | N/A | N/A | N/A | N/A | N/A |
| Girls | 0.65 | 0.31 | 1.33 | N/A | N/A | N/A | N/A | N/A | N/A |
| *Age in years* | | | | | | | | | |
| 11–12 | | | | 1.00 [reference category] | | | | | |
| 13–14 | 0.65 | 0.36 | 1.17 | 0.48 | 0.12 | 1.93 | 0.60 | 0.18 | 2.01 |
| 15–16 | 0.61 | 0.31 | 1.18 | 0.65 | 0.29 | 1.43 | 0.32 | 0.05 | 1.94 |
| 17–18 | 0.48 | 0.19 | 1.20 | 0.37 | 0.08 | 1.77 | 0.24 | 0.05 | 1.09 |
| *Nationality* | | | | | | | | | |
| Saudi | 0.37* | 0.17 | 0.83 | 0.38* | 0.15 | 0.98 | 0.26 | 0.07 | 1.06 |
| Non-Saudi | | | | 1.00 [reference category] | | | | | |
| *Screen time per day* | | | | | | | | | |
| ≤ 2 h | 2.10 | 0.64 | 6.91 | 5.05 | 0.65 | 39.0 | 1.23 | 0.70 | 2.17 |
| > 2 h | | | | 1.00 [reference category] | | | | | |
| *Fast-food consumption per week* | | | | | | | | | |
| ≤ 2 times | | | | 1.00 [reference category] | | | | | |
| > 2 times | 0.99 | 0.50 | 1.94 | 1.34 | 0.51 | 3.51 | 0.46 | 0.20 | 1.05 |
| *Diet quality* | | | | | | | | | |
| Quartile 1 | 0.91 | 0.28 | 2.99 | 1.62 | 0.30 | 8.70 | 0.39 | 0.08 | 2.03 |
| Quartile 2 | 1.39 | 0.49 | 3.99 | 2.56 | 0.59 | 11.2 | 0.72 | 0.17 | 2.99 |
| Quartile 3 | 1.21 | 0.43 | 3.45 | 1.77 | 0.31 | 10.1 | 0.69 | 0.21 | 2.33 |
| Quartile 4 | | | | 1.00 [reference category] | | | | | |
| **Parental characteristics** | | | | | | | | | |
| *Maternal age* | | | | | | | | | |
| 28–40 years | | | | 1.00 [reference category] | | | | | |
| 41–49 years | 1.02 | 0.52 | 2.03 | 0.74 | 0.33 | 1.67 | 1.48 | 0.37 | 5.89 |
| ≥ 50 years | 0.77 | 0.19 | 3.06 | 1.30 | 0.23 | 7.53 | 0.50 | 0.04 | 6.25 |
| *Maternal education status* | | | | | | | | | |
| ≤ High school | 0.53 | 0.09 | 3.11 | 0.81 | 0.07 | 8.79 | 0.20 | 0.03 | 1.28 |
| College degree | 0.69 | 0.21 | 2.23 | 1.41 | 0.38 | 5.21 | 0.25 | 0.06 | 1.00 |
| Postgraduate degree | | | | 1.00 [reference category] | | | | | |
| *Maternal employment status* | | | | | | | | | |
| Unemployed | 1.35 | 0.71 | 2.56 | 1.79 | 0.73 | 4.37 | 1.41 | 0.74 | 2.70 |
| Employed | | | | 1.00 [reference category] | | | | | |
| *Paternal age* | | | | | | | | | |
| 28–40 years | | | | | | | | | |
| 41–49 years | 1.56 | 0.73 | 3.35 | 1.89 | 0.79 | 4.59 | 1.58 | 0.36 | 6.99 |
| ≥ 50 years | 1.01 | 0.50 | 2.03 | 1.23 | 0.50 | 3.02 | 1.00 | 0.30 | 3.35 |
| *Paternal education status* | | | | | | | | | |
| ≤ High school | 2.09 | 0.50 | 8.77 | 1.35 | 0.25 | 7.47 | 4.98 | 0.28 | 88.2 |
| College degree | 1.48 | 0.52 | 4.22 | 1.49 | 0.58 | 3.87 | 2.46 | 0.24 | 25.5 |
| Postgraduate degree | | | | 1.00 [reference category] | | | | | |
| *Paternal employment status* | | | | | | | | | |
| Unemployed | 1.01 | 0.39 | 2.60 | 1.44 | 0.56 | 3.72 | 0.90 | 0.18 | 4.47 |

**Table 2** (continued)

| Characteristics | Overweight/obesity to reference category | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total sample | | | Boys | | | Girls | | |
| | OR | 95% CI | | OR | 95% CI | | OR | 95% CI | |
| | | Lower | *Upper* | | Lower | *Upper* | | Lower | *Upper* |
| Employed | | | | 1.00 [reference category] | | | | | |
| *Household income in Saudi Riyals* | | | | | | | | | |
| < 6,000 | 0.35 | 0.10 | 1.16 | 0.24* | 0.07 | 0.86 | 0.22 | 0.02 | 2.56 |
| 6,000 to < 11,000 | 0.50 | 0.16 | 1.55 | 0.44 | 0.09 | 2.17 | 0.26 | 0.05 | 1.43 |
| 11,000 to < 16,000 | 0.77 | 0.29 | 2.08 | 0.28 | 0.06 | 1.37 | 0.93 | 0.22 | 3.93 |
| 16,000 to < 20,000 | 0.72 | 0.29 | 1.79 | 0.82 | 0.12 | 5.81 | 0.51 | 0.19 | 1.36 |
| ≥ 20,000 | | | | 1.00 [reference category] | | | | | |
| *Family type* | | | | | | | | | |
| Both parents | | | | 1.00 [reference category] | | | | | |
| Single parents | 1.98* | 1.02 | 3.85 | 2.08 | 0.79 | 5.47 | 1.54 | 0.43 | 5.46 |
| **Parental Weight Status** | | | | | | | | | |
| *Maternal weight status* | | | | | | | | | |
| Overweight | 1.63 | 0.70 | 3.79 | 2.28 | 0.94 | 5.52 | 1.17 | 0.27 | 5.01 |
| Obesity | 2.43* | 1.12 | 5.25 | 1.56 | 0.29 | 8.56 | 3.06* | 1.17 | 8.01 |
| Underweight/healthy weight | | | | 1.00 [reference category] | | | | | |
| *Paternal weight status* | | | | | | | | | |
| Overweight | 1.52 | 0.94 | 2.46 | 1.71 | 0.91 | 3.21 | 1.21 | 0.64 | 2.30 |
| Obesity | 1.96 | 0.96 | 4.00 | 2.02 | 0.71 | 5.76 | 2.53 | 0.91 | 6.98 |
| Underweight/healthy weight | | | | 1.00 [reference category] | | | | | |

* Significant based on 95% confidence intervals

[a] ORs and CIs are adjusted for complex sampling design. Dependent variable: adolescent overweight or obesity status. Model: (Intercept), adolescent sex (for the total sample) and age, nationality, screen time per day, fast-food consumption per week, dietary quality, parental age, education, and employment status, family income, family type, and parental weight status

*BMI* Body mass index, *CI* Confidence interval

**Table 3** Odds ratios (ORs) for the association between adolescent overweight/obesity status and the coexistence of parental overweight or obesity[a]

| Parental/adolescent overweight/obesity status | Overweight/obesity to reference category | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total sample | | | Boys | | | Girls | | |
| | OR | 95% confidence interval | | OR | 95% confidence interval | | OR | 95% confidence interval | |
| | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| **Parental overweight status** | | | | | | | | | |
| Single parent | 0.55* | 0.31 | 0.97 | 0.75 | 0.41 | 1.36 | 0.37* | 0.14 | 0.99 |
| Both parents | 1.83 | 0.69 | 4.88 | 3.08* | 1.30 | 7.26 | 0.73 | 0.09 | 5.78 |
| None | | | | 1.00 [reference category] | | | | | |
| **Parental Obesity status** | | | | | | | | | |
| Single parent | 1.80 | 0.81 | 4.02 | 1.45 | 0.56 | 3.80 | 3.03 | 0.94 | 9.71 |
| Both parents | 2.79* | 1.39 | 5.64 | 1.59 | 0.61 | 4.20 | 5.37* | 1.62 | 17.9 |
| None | | | | 1.00 [reference category] | | | | | |

* Significant based on 95% confidence intervals

[a] ORs and CIs are adjusted for complex sampling design. Dependent variable: adolescent overweight or obesity status. Model: (Intercept), adolescent sex (for the total sample) and age, nationality, screen time per day, fast-food consumption per week, dietary quality, parental age, education, and employment status, family income, family type, and (parental overweight status or parental obesity status)

households have higher odds of Ow/Ob compared to dual-parent households. A systematic review of 10 studies indicated consistent evidence for higher obesity risk in children living in single-parent households [45]. Although the causal mechanism is not clearly defined, it is possible that single-parent families are experiencing financial constraints to healthy food options [46], time limitation for a single parent to prepare healthy homemade meals and monitor child children's food intake and physical activity [46, 47], and psychological stress particularly during family structure transition [48], which may interrupt healthy eating behaviors or increase sedentary behaviors [46].

Obesity is a condition resulting from a complex interplay between genetic, environmental, and behavioral factors [49], suggesting family susceptibility of becoming obese. Previous research has shown significant associations between maternal and paternal weight status with adolescents' obesity in different settings [22], with stronger associations observed in adolescent boys. In the present study, only maternal obesity was associated with adolescents' Ow/Ob status, particularly among adolescent girls. This could be explained by the misperception of mothers, in particular, with obesity for children's weight status as they tend to underestimate excess body weight compared to healthy weight mothers [50]. Additionally, the adolescent girls in Saudi Arabia tend to spend more time with their families and eat more frequently from home compared to boys who typically eat out more frequently [30]. As such, it is possible that daughters may have extended time to interact with their mothers compared to adolescent boys.

Parental obesity, particularly maternal obesity, has been reported as a significant predictor of obesity in children and adolescents [22, 51]. Early experiences with food occur in the home environment as parents become responsible for cooking as well as influencing eating behaviors of their children through parental modeling [52]. In line with previous findings [22, 51], our data showed that having a single parent with overweight is negatively associated with adolescent Ow/Ob, whereas the co-existence of parental obesity increases odds for obesity in adolescents. Interestingly, the classification analyses by adolescent sex indicate that these associations are mostly limited to adolescent girls despite the significantly higher prevalence of obesity among the boy adolescents. Apart from heredity, these observations could be related to gender differences in daughter- and son-parents relationships and lifestyle practices within the home food environment that play a significant role particularly for girl adolescents [53]. However, research is still needed to determine the mechanism of the associations and transmission of lifestyle and eating behaviors from parents to adolescents.

Intervention studies suggest successful initiatives for preventing and treating overweight and obesity in adolescence [54–56]. Adolescents may benefit from multicomponent intervention programs focusing on dietary intake and physical activity modification and behavioral counseling for weight loss. In fact, school-based interventions should integrate environmental and behavioral approaches to promote healthy diet and physical activity [54]. For instance, the schools may provide education programs discouraging the consumption of sugar sweetened beverages, encouraging fruit intake, and promoting water consumption [57] while canteens could be directed to sell healthy foods [58]. Additionally, organizing sports and physical education programs based on interest and input from teachers is also considered an effective approach to manage overweight and obesity [58]. Furthermore, the existing evidence suggest that family-based behavioral weight loss interventions could be effective at improving the weight status of adolescents in the short- and long-term [56, 59]. Thus, incorporating parents and promoting family-based approaches such as nutrition education, dietary counseling, parenting skills, behavioral strategies, and physical-activity promotion may facilitate favorable lifestyle changes and obesity prevention and management (54, 58).

The present study provides up-to- date data concerning the prevalence of overweight and obesity among adolescents in Saudi Arabia. A key strength of the study is the use of complex sampling adjustments to account for multistage sampling design, which enhances the accuracy and generalizability of the study findings. Anthropometric measurements of adolescents were objectively assessed using a standardized protocol; the weight status was determined based on the WHO growth standards to facilitate global comparison of overweight and obesity. Additionally, this study is the first to examine the association of maternal and paternal overweight and obesity status with the weight status of adolescents within the nation of Saudi Arabia. However, the present study has a few limitations. The cross-sectional design limited the ability to infer causality. Moreover, parental anthropometric data were self-reported, which may be subject to recall bias. Furthermore, findings of the present study may be subject to nonresponse bias due to the low recruitment rate. Generalizability of the study findings might be limited to healthy school-going adolescents residing in the Western region of Saudi Arabia. Future research should aim to include out-of-school adolescents, and to incorporate a wider range of factors, such as physical activity level, influence of peers, body image and

self-esteem, and sleep patterns, to provide a more comprehensive understanding.

## Conclusions

A high prevalence of overweight and obesity was observed among the study sample, especially among adolescent boys. Findings also revealed significant associations between adolescent Ow/Ob and several socioeconomic factors. Maternal weight status and the coexistence of parental obesity were found to be significant correlates with adolescent Ow/Ob, particularly in girls. These findings emphasize the importance of the family environment in adolescent obesity and the necessity to enroll parents when implementing obesity prevention programs. Health promotion strategies should prioritize environmental changes that support healthy lifestyle and dietary practices within families. Comprehensive interventions that engage both adolescents and their families are essential to eliminate the rising obesity trends.

### Abbreviations

| | |
|---|---|
| WHO | World Health Organization |
| SFFFQ | Short-form food frequency questionnaire |
| BMI | Body mass index |
| U/HW | Under- and healthy weight |
| Ow/Ob | Overweight or obesity |
| OR | Odds ratio |
| CI | Confidence interval |

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12887-025-05633-5.

Supplementary Material 1

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### Authors' contributions

H.K. designed the study, performed the analyses, and wrote the main manuscript. W.M. made substantial contributions to the study design and conception, and substantively revised the manuscript. All authors read and approved the final manuscript.

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### Data availability

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

## Declarations

### Ethics approval and consent to participate

Ethical approval was granted from the Ethics and Research Committee of the Faculty of Applied Medical Sciences at King Abdulaziz University (FAMS-EC2021 - 13). Parents of adolescents included in the study provided written informed consents for participation.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

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