Research Article

Prevalence of Obesity and its Relationship to Lifestyle among Secondary School Students in Mosul city, Iraq

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Abstract

Background: Overweight and obesity rates are disproportionately higher in poorer areas, yet there is a shortage of research on child and adolescent health-related practices that may guide the creation of effective interventions. The aim of this study was to determine the prevalence of obesity and identify lifestyle factors associated with obesity among secondary school students in Mosul city. **Subjects and Methods:** A descriptive, cross-sectional study was conducted on 820 students in secondary schools in Mosul city. The study used a multistage stratified random technique, namely a random sampling technique, to choose students through body anthropometric measurements and direct interviews. Data collection continued for a period of 4 months, starting on 15th December 2025 and ending on 1st April 2026. **Results:** The present research determined that the prevalence of obesity among students in Mosul city was 96 (11.7; 95% CI; 9.5–14.0), and the prevalence of overweight was 158 (19.3; 95% CI; 16.5–22.0). Significant associations were found between obesity and sex. Boys had a higher prevalence of obesity (16.7%) compared to girls (6.7%). Higher levels of maternal education, higher occupational levels of both parents, higher income, and higher socioeconomic status were associated with a higher prevalence of obesity compared to other levels. Students with a positive first-degree family history had a significantly higher risk (23.7%) compared to those without a family history (7.7%). Prolonged periods of physical activity, such as football and basketball, (≥ 2 hours/day) appeared to have a protective influence against obesity compared to shorter periods. Students who slept less than 8 hours were more likely to be obese (14.4%) compared to students who slept 8 hours or more (8.1%). Students who ate 3 meals or more per day were more likely to be obese (35.5%) compared to students who ate fewer than 3 meals per day (9.3%). **Conclusion:** This study in Mosul identified a concerning prevalence of overweight and obesity (31%) among secondary school students, with boys showing a higher prevalence of obesity. The study identified family history, dietary choices, physical activity levels, occupational levels of both parents, higher income, higher socioeconomic status, sleeping less than 8 hours, and frequent meals as significantly associated with an increase in obesity.

Keywords: obesity, overweight, lifestyle, secondary school students, Mosul, Iraq.

1. Introduction

Adolescent obesity rates have consistently increased over the past few decades, following more general trends in both industrialized and developing countries [1], despite some high-income areas showing signs of stability [2]. According to Drozdz et al. (2021), children who are obese are more likely to acquire cardiometabolic risk factors [3].The promotion of good lifestyle choices, such as reducing energy consumption and increasing physical exercise, is the primary focus of efforts to prevent childhood obesity, since obesity is caused by a chronic energy imbalance [4]. Excess body weight raises major health and social issues throughout adolescence, a crucial period of physical and mental development. This period frequently signifies the beginning of lifestyle decisions that tend to last throughout adulthood, such as eating habits, levels of physical activity, and screen use [5]. Obesity is a complex condition that is influenced by physiological, psychological, social, behavioral, environmental, and genetic factors [6]. The complex interplay between genetics and poor lifestyle choices is one of the many causes of obesity. Studies on common genetic variants contributing to obesity in children and adolescents have revealed that the heritability of obesity varies from 50% to 80% in children, exceeding adult estimates due to stronger genetic influences early in life [7].

2. Subjects and Methods

2.1 Design of the Study

A descriptive, cross-sectional study was conducted on 820 students.

2.2 Setting of the Study

The study was conducted among secondary school students in Mosul city, Nineveh Governorate.

2.3 Sample Size

According to the Dobson equation, the sample size (n) was calculated [8].

$$n = Z^2P(1 - P)/d^2.$$

The level of confidence of this study was 95%, the Z value was equal to 1.96, and P represented the preva-lence of obesity in Basrah, Iraq, where the overall prevalence rate of obesity among students in intermediate schools was 22.6%. A value of 0.03 was used as the margin of error for this study [9]. At the time of the study, the total number of students was 195180. Therefore, the sample size was equal to 744; however, we selected 820 students to strengthen the study

2.4 Sampling Methods

The selected total sample consisted of 820 students from the right and left sides of Mosul. A multistage stratified random selection method was used to provide sufficient geographic and demographic coverage. In the first stage, the right and left sides of Mosul were used as the geographically stratified study population. According to the proportional distribution of the students, 279 students (34 per cent) from the right side and 541 students (66 per cent) from the left side were chosen based on the actual population distribution, reducing selection bias. The second stage involved stratifying schools on each side by type (public and private) and gender (boys' and girls' schools). Simple random sampling was then used to select approximately 10 percent of the total number of schools on each side and to ensure that geographic dispersion was achieved across the districts in order to maximize spatial representativeness. As such, 11 schools were sampled on the right side and 23 on the left side, and they were evenly divided in terms of boys' and girls' schools. The third stage involved the random selection of a specific number of students from each of the selected schools based on geographical side and gender. In particular, approximately 23 boys and 27 girls were recruited from schools on the right side, and approximately 22 boys and 24 girls were recruited from schools on the left side from each school. This was done to ensure equal gender representation on each side and also to maintain the predetermined total sample size. At the fourth stage, a stratified sampling method was used in every selected school based on the level of education, either intermediate or secondary. These levels were then allocated the number of students per school in proportion to the actual enrollment. In the event that there were multiple sections of the same grade, further stratification by classroom was carried out, and one or two classroom sections were selected, again considering that the number of students in the classroom after selection had to be at least twice the number of students required to be sampled, effectively permitting systematic sampling to be practiced. In the fifth stage, systematic random sampling was used to select the students. The division of the total number of students in the selected class by the number of required participants was used in calculating the sampling interval. One randomly selected starting point was followed by the selection of every kth student until the target number was reached. This geographically distributed multistage stratified design, with consideration of geographic distribution, school type, gender, and educational level, decreased selection bias and increased statistical accuracy.

2.5 Method of Data Collection

The data were collected through direct interviews with the students after translating the questionnaire into the local language (Arabic), using close-ended questions. Body anthropometric measurements were taken for every

student using a weighing scale to measure body weight, a length tape measure for measuring height, and a tape measure for mid-arm circumference.

2.6 Statistical Analysis

The information for each item on the questionnaire was copied to code sheets, the data were entered into a personal computer, and the Statistical Package for Social Sciences, SPSS-27, was used to evaluate the data. Simple statistics such as frequency, percentage, average, standard deviation, and range were used to display the data. The chi-square test (X^2-test) or Fisher's exact test was utilized to identify the significance of qualitative data percentage differences. Multivariate logistic regression analysis was used to identify factors associated with obesity. The P-value was considered statistically significant when it was equal to or less than 0.05.

3 Results

3.1 Prevalence of Obesity

The current study indicated that 7.0% of students were underweight, 19.3% were overweight, and 11.7% were obese, whereas 62.1% of students had normal weight. The mean weight was 58.1 ± 15.1 kg (range: 22.0–110.0 kg), and the mean height was 159.4 ± 10.6 cm (range: 127.0–188.0 cm), as shown in Table 1.

Table 1: The distribution of the students according to body mass index categories

Anthropometric measure		**No.**	**%**	**95% CI**	**Prevalence per 1000**
Body mass index	Underweight	57	7.0	5.2–8.7	70 per 1000
	Normal weight	509	62.1	58.9–65.5	
	Overweight	158	19.3	16.5–22.0	193 per 1000
	Obesity	96	11.7	9.5–14.0	117 per 1000
Weight in kg		Mean ± SD (range): 58.1 ± 15.1 (22.0–110.0)			
Height in cm		Mean ± SD (range): 159.4 ± 10.6 (127.0–188.0)			

There was a statistically significant association between BMI categories and socio-demographic character-istics, including sex, school type, educational level of the mother, occupation of the mother and father, family income, socio-economic status, and first-degree family history of obesity, where the P-value was <0.05. This explains the higher obesity rate among boys (16.7%) compared to girls (6.7%). Furthermore, the obesity rate was higher among private school students than among public school students (12.8% versus 11.4%). The educational level of the mother was associated with obesity within the levels of primary education and college and above. High occupation of the mother and father, high income, and high socio-economic class were associated with obesity at a significant level of <0.05. Finally, those with a first-degree family history of obesity were more likely to be obese (23.7%) compared to those without a history of obesity (7.7%) at a significance level of <0.001, as shown in Table 2.

Table 2: The association between BMI categories and socio-demographic characteristics

Variable	**Underweight No. (%)**	**Normal weight No. (%)**	**Overweight No. (%)**	**Obesity No. (%)**	**P-value**
Age groups					0.375
12–14 years	20 (5.9%)	202 (59.6%)	71 (20.9%)	46 (13.6%)	
15–17 years	25 (6.9%)	231 (63.8%)	65 (18.0%)	41 (11.3%)	

≥18 years	12 (10.1%)	76 (63.9%)	22 (18.5%)	9 (7.6%)	
Sex					<0.001*
Boy	39 (9.4%)	236 (57.0%)	70 (16.9%)	69 (16.7%)	
Girl	18 (4.4%)	273 (67.2%)	88 (21.7%)	27 (6.7%)	
Grade					0.114
1st class	9 (5.7%)	95 (60.1%)	27 (17.1%)	27 (17.1%)	
2nd class	8 (5.8%)	84 (60.9%)	27 (19.6%)	19 (13.8%)	
3rd class	11 (8.0%)	73 (53.3%)	35 (25.5%)	18 (13.1%)	
4th class	9 (6.9%)	88 (67.2%)	21 (16.0%)	13 (9.9%)	
5th class	5 (4.3%)	79 (68.7%)	24 (20.9%)	7 (6.1%)	
6th class	15 (10.6%)	90 (63.8%)	24 (17.0%)	12 (8.5%)	
School type					0.001*
Public	57 (8.7%)	402 (61.3%)	122 (18.6%)	75 (11.4%)	
Private	0 (0.0%)	107 (65.2%)	36 (22.0%)	21 (12.8%)	
Educational level of father					0.821
Illiterate	3 (15.8%)	9 (47.4%)	4 (21.1%)	3 (15.8%)	
Read & write	1 (8.3%)	8 (66.7%)	1 (8.3%)	2 (16.7%)	
Primary	18 (6.9%)	169 (65.0%)	43 (16.5%)	30 (11.5%)	
Intermediate	5 (6.7%)	48 (64.0%)	14 (18.7%)	8 (10.7%)	
Secondary	16 (7.9%)	115 (56.7%)	44 (21.7%)	28 (13.8%)	
College and above	14 (5.6%)	160 (63.7%)	52 (20.7%)	25 (10.0%)	
Educational level of mother					<0.001*
Illiterate	7 (18.4%)	23 (60.5%)	5 (13.2%)	3 (7.9%)	
Read & write	1 (4.5%)	14 (63.6%)	4 (18.2%)	3 (13.6%)	
Primary	27 (7.6%)	229 (64.1%)	49 (13.7%)	52 (14.6%)	
Intermediate	3 (7.0%)	22 (51.2%)	14 (32.6%)	4 (9.3%)	
Secondary	12 (6.9%)	112 (64.7%)	42 (24.3%)	7 (4.0%)	
College and above	7 (3.7%)	109 (58.3%)	44 (23.5%)	27 (14.4%)	
Occupation of father					0.003*
Unskilled workers	29 (9.6%)	195 (64.8%)	47 (15.6%)	30 (10.0%)	
Lower professionals, skilled, semiskilled workers	28 (5.8%)	296 (61.5%)	96 (20.0%)	61 (12.7%)	
High professional and managerial jobs	0 (0.0%)	18 (47.4%)	15 (39.5%)	5 (13.2%)	
Occupation of mother					0.027*
Unskilled workers	51 (7.8%)	411 (62.5%)	120 (18.2%)	76 (11.6%)	
Lower professionals, skilled, semiskilled workers	6 (4.8%)	81 (65.3%)	24 (19.4%)	13 (10.5%)	
High professional and managerial jobs	0 (0.0%)	17 (44.7%)	14 (36.8%)	7 (18.4%)	
Family income					<0.001*
Not sufficient or marginally sufficient	19 (41.3%)	15 (32.6%)	6 (13.0%)	6 (13.0%)	
Sufficient for daily needs	38 (5.4%)	461 (66.0%)	122 (17.5%)	78 (11.2%)	
Exceeds daily needs	0 (0.0%)	33 (44.0%)	30 (40.0%)	12 (16.0%)	
Socio-economic status					0.001*
Low (<12 score)	33 (9.5%)	223 (64.5%)	48 (13.9%)	42 (12.1%)	
Medium (12–16 score)	21 (5.7%)	228 (61.8%)	77 (20.9%)	43 (11.7%)	
High (>16 score)	3 (2.9%)	58 (55.2%)	33 (31.4%)	11 (10.5%)	
Do you have a first-degree family history of obesity?					<0.001*
No	54 (8.8%)	404 (65.9%)	108 (17.6%)	47 (7.7%)	
Yes	3 (1.4%)	105 (50.7%)	50 (24.2%)	49 (23.7%)	

*Statistically significant at $p<0.05$

3.2 Behavioural Characteristics

The findings showed that 79.6% of the students practiced exercise, and 35.2% of them exercised for less than 30 minutes. The most popular physical activities among the students were team sports, such as football and basketball (45.5%). Meanwhile, 57.1% of students exercised one to two days per week. The most common mode of transportation among students was walking (46.3%). More than half of the students (59.6%, 69.5%, 55.5%, and 56.6%) reported eating before bedtime, eating between meals, eating while watching television, and sleeping less than 8 hours a day, respectively. Moreover, 90.7% of students ate fewer than 3 meals per day. Finally, 46.3% of the participants spent 5 hours or more per day watching TV or using electronic devices, as shown in Table 3.

Table 3: The distribution of the students according to their behavioural characteristics

Behavioural characteristics	**No.**	**%**
Do you practice exercise?		
No	167	20.4
Yes	653	79.6
If yes, how many hours per day do you usually spend doing this physical activity?		
Less than 30 minutes	230	35.2
30 minutes to less than 1 hour	179	27.4
1 to less than 2 hours per day	178	27.3
2 hours or more per day	66	10.1
If yes, what kind of physical activity do you usually do? (You can choose more than one)		
Walking	237	36.3
Running	56	8.6
Team sports (football, basketball, etc.)	297	45.5
Others	63	9.6
If yes, how many days per week do you do physical activity?		
1–2 days	373	57.1
3–4 days	126	19.3
5 days or more	154	23.6
What is your usual mode of transportation to school?		
Walk	380	46.3
Bicycle	26	3.2
Family vehicle	107	13.0
Public transportation	307	37.4
Do you eat before bedtime?		
No	331	40.4
Yes	489	59.6
Do you eat between meals?		
No	250	30.5
Yes	570	69.5
Do you eat while watching TV?		
No	365	44.5
Yes	455	55.5
Average sleeping hours (hrs./per day)		
<8 hours	464	56.6
≥ 8 hours	356	43.4
Number of meals you eat per day		
< 3 times	744	90.7
≥ 3 times	76	9.3
Number of hours a day spent watching TV or using electronic devices		
1–2 hours	98	12.0
3–4 hours	342	41.7

≥ 5 hours	380	46.3

There was a statistically significant association between BMI categories and behavioural characteristics, including the number of hours per day usually spent doing physical activity, the kind of physical activity, the number of days per week spent doing physical activity, the usual mode of transportation to school, average sleeping hours, and the number of meals per day, where the P-value was <0.05, as shown in Table 4.

Table 4: The association between BMI categories and behavioural characteristics

Variable	Underweight No. (%)	Normal weight No. (%)	Overweight No. (%)	Obesity No. (%)	P-value
Do you practice exercise?					0.846
No	13 (7.8%)	102 (61.1%)	30 (18.0%)	22 (13.2%)	
Yes	44 (6.7%)	407 (62.3%)	128 (19.6%)	74 (11.3%)	
If yes, how many hours per day do you usually spend doing this physical activity?					0.022*
Less than 30 minutes	8 (3.5%)	154 (67.0%)	52 (22.6%)	16 (7.0%)	
30 minutes to less than 1 hour	15 (8.4%)	100 (55.9%)	38 (21.2%)	26 (14.5%)	
1 to less than 2 hours per day	16 (9.0%)	107 (60.1%)	29 (16.3%)	26 (14.6%)	
2 hours or more per day	5 (7.6%)	46 (69.7%)	9 (13.6%)	6 (9.1%)	
If yes, what kind of physical activity do you usually do?					0.010*
Walking	7 (3.0%)	144 (60.8%)	54 (22.8%)	32 (13.5%)	
Running	2 (3.6%)	34 (60.7%)	13 (23.2%)	7 (12.5%)	
Team sports (football, basketball, etc.)	33 (11.1%)	188 (63.3%)	47 (15.8%)	29 (9.8%)	
Others	2 (3.2%)	41 (65.1%)	14 (22.2%)	6 (9.5%)	
If yes, how many days per week do you do physical activity?					0.002*
1–2 days	29 (7.8%)	209 (56.0%)	93 (24.9%)	42 (11.3%)	
3–4 days	5 (4.0%)	91 (72.2%)	16 (12.7%)	14 (11.1%)	
5 days or more	10 (6.5%)	107 (69.5%)	19 (12.3%)	18 (11.7%)	
What is your usual mode of transportation to school?					0.008*
Walk	38 (10.0%)	236 (62.1%)	57 (15.0%)	49 (12.9%)	
Bicycle	1 (3.8%)	20 (76.9%)	2 (7.7%)	3 (11.5%)	
Family vehicle	3 (2.8%)	65 (60.7%)	26 (24.3%)	13 (12.1%)	
Public transportation	15 (4.9%)	188 (61.2%)	73 (23.8%)	31 (10.1%)	
Do you eat before bedtime?					0.442
No	25 (7.6%)	205 (61.9%)	57 (17.2%)	44 (13.3%)	
Yes	32 (6.5%)	304 (62.2%)	101 (20.7%)	52 (10.6%)	
Do you eat between meals?					0.130
No	24 (9.6%)	147 (58.8%)	45 (18.0%)	34 (13.6%)	
Yes	33 (5.8%)	362 (63.5%)	113 (19.8%)	62 (10.9%)	
Do you eat while watching TV?					0.066
No	31 (8.5%)	233 (63.8%)	57 (15.6%)	44 (12.1%)	
Yes	26 (5.7%)	276 (60.7%)	101 (22.2%)	52 (11.4%)	
Average sleeping hours (hrs./per day)					0.004*
<8 hours	24 (5.2%)	278 (59.9%)	95 (20.5%)	67 (14.4%)	
≥ 8 hours	33 (9.3%)	231 (64.9%)	63 (17.7%)	29 (8.1%)	
Number of meals you eat per day					<0.001*
< 3 times	56 (7.5%)	489 (65.7%)	130 (17.5%)	69 (9.3%)	
≥ 3 times	1 (1.3%)	20 (26.3%)	28 (36.8%)	27 (35.5%)	
Number of hours a day spent watching TV or using electronic devices					0.750
1–2 hours	10 (10.2%)	60 (61.2%)	20 (20.4%)	8 (8.2%)	
3–4 hours	21 (6.1%)	217 (63.5%)	63 (18.4%)	41 (12.0%)	
≥ 5 hours	26 (6.8%)	232 (61.1%)	75 (19.7%)	47 (12.4%)	

*Statistically significant at p<0.05

4 Discussion

The present research determined that the prevalence of obesity and overweight among students in Mosul city was 96 (11.7; 95% CI; 9.5–14.0), and overweight was 158 (19.3; 95% CI; 16.5–22.0). These results agreed with the study findings conducted among secondary school students in Slemani city, Kurdistan Region, Iraq, which found that the prevalence of overweight and obesity was 20.6% and 11.3%, respectively [10]. However, these results were lower than those of the study conducted in Basrah, Iraq, which revealed that the overall prevalence rates of overweight and obesity among adolescents aged 13–15 years in intermediate schools were 20.6% and 22.6%, respectively [9]. Furthermore, in Sulaimani city, the overall prevalence of obesity among high school students was 33.74% [11]. Likewise, the prevalence of overweight and obesity among adults in Zakho City was significantly high [12]. Also, this study was lower than the study conducted in Ghana, where the prevalence of obesity among students was 16.4% [13], in China, where the prevalence was 20.0% [14], and in New Zealand, where the prevalence was 26.6% [15]. On the other hand, this study was higher than the previous study conducted in Erbil City, Kurdistan, Iraq, where the prevalence rate of obesity was found to be 7.7% [16]. Besides, in a study conducted among adolescents in secondary schools in Al-Karkh, Baghdad, Iraq, the prevalence of obesity among the studied group was 7.6% [17]. In Morocco, the estimated rates of overweight and obesity among adolescents aged 12–18 years were 7.69% and 3.41%, respectively [18]. In Duhok secondary schools, 7% of the teenagers tested

were obese [19]. In Croatia, a study by [20] found that 11% of secondary students were overweight and 4.4% were obese. In Dongola City, Northern Sudan, the prevalence rates of overweight and obesity were 15.7% and 5.2%, respectively [21]. The results of these comparative studies were lower than the results of our study. The possible explanation for these variations from previous studies may be that the prevalence of obesity among secondary school students in Mosul is lower or higher than in other studies due to a combination of several factors. First, variations in socioeconomic and environmental factors, such as reduced household in-come and access to high-energy processed foods, could decrease the overconsumption of calories, particularly in conflict-prone or resource-constrained conditions [18, 22]. Second, increased academic pressure during middle and high school may also play a role in weight loss among adolescents [20]. Third, methodological variations, such as differences in BMI cut-off levels between WHO and IOTF, can have a great effect on the prevalence rates reported in studies [23]. In this study, the overall prevalence of obesity among secondary school students was higher in boys than in girls. These findings were consistent with the study outcomes conducted in the Kurdistan Region of Iraq, where males were more likely to be obese compared to females (p=0.023) [24]. Furthermore, these results agreed with a study conducted in Dakshina Kannada and Udupi [25], which found that the overall prevalence of obesity was higher in males than in females. Likewise, in an Indian state, a study by [26] reported that the prevalence of overweight and obesity was higher among boys at a statistically significant level ($p<0.001$). A systematic review of Asian adolescents established that the frequency of obesity was greater in males (10.1%) than in females (6.2%) [27]. A cross-sectional study in Romania revealed that obesity was more common in boys than in girls [28]. In most high-income and upper-middle-income countries, boys are more likely to be obese than girls [29, 30]. The possible explanation of these results may be that body image and self-esteem are more crucial in forming identity in girls compared to boys [20]. The possible explanation that obesity is not as prevalent among girls compared to boys is that body image and self-esteem are more central to identity formation among adolescent females, and this can have a strong impact on how they behave with regard to their health [31, 20]. However, studies on adolescent psychology demonstrate that girls tend to be more interested in body weight, appearance, and social acceptability, which may lead them to adopt dietary restraint and weight-control practices and to give more consideration to body shape than boys [31]. Another study found that girls tend to report higher levels of weight-related concerns compared to boys, including a greater desire to lose weight [32]. Another explanation may be that the differences could also be attributed to distinct genes contributing to differences in body composition between males and females [33]. Our study discovered that higher levels of maternal education, higher occupational levels of both parents, higher income, and higher socioeconomic status were associated with a higher prevalence of obesity compared to other levels. These results agreed with [17], which found that higher education of the father and mother was associated with an increased prevalence of obesity. Furthermore, a study by [10] found that variables significantly associated with overweight and obesity included high monthly family income and high educational level of parents. In addition, a similar study found that there was a statistically significant correlation between SES and overweight and obese students [34]. Similarly, a study by [35] revealed that higher family income and parents' education levels may be associated with an increased risk of childhood obesity. Lifestyle and environmental factors related to greater wealth may explain why the prevalence of obesity among students from high socioeconomic status (SES) families was higher. High-SES groups of adolescents tend to have better access to energy-rich foods, fast foods, and high-calorie beverages, and they have higher purchasing power, which may encourage greater consumption of calories [36, 37]. However, these results were inconsistent with [38], which found that in developed nations, low socioeconomic status is associated with a higher prevalence of obesity. The possible explanation for this difference may be due to an economic, environmental, and behavioral combination. Low-SES people frequently do not have access to healthy and nutritious foods, as healthier foods, such as fruits, vegetables, and lean proteins, are expensive, whereas low-cost processed foods with high energy content are easily obtained [39]. This study showed that participants with a first-degree family history of obesity are more likely to be obese compared to those without a history of obesity. This result aligns with the study findings conducted in Baghdad, Iraq [40], which found that family history of obesity was more strongly related to obesity. A similar study by [24] discovered that there was an association between family history of obesity and obesity in children (P=0.019). Similarly, these results agreed with [21], who reported that students with a family history of obesity were almost twice and two and a half times more likely to have overweight and obesity, respectively (OR=1.78; 95% CI: 1.15–2.76) and (OR=2.46; 95% CI: 1.21–4.98). The possible explanation of this result may be that those who have a first-degree family history of obesity have a higher likelihood of inheriting genes that control appetite, metabolism, and fat storage, thereby increasing their biological predisposition to gain weight [41, 42]. Prolonged periods of physical activity ($\geq$ 2 hours/day) seem to have a protective influence against obesity compared to shorter periods. This result agreed with [43], which found that longer physical activity

duration acts as a natural health protector in young populations. This can be explained by the fact that prolonged activity induces a long-term negative energy balance, in which energy expenditure is greater than caloric intake, and thus fat accumulation is inhibited. Increased duration of activity also enhances metabolic efficiency, with improvements in insulin sensitivity, lipid metabolism, and fat oxidation, all of which decrease the potential for weight gain [44]. Moreover, spending more time in physical activity is likely to decrease sedentary habits, such as screen time, which are closely associated with obesity among adolescents. The results of this study indicated that physical activities such as football and basketball, and engaging in physical activities several days a week, are protective factors against obesity. These results agreed with [45], which found that active commuting to school and engaging in physical activities several days a week were inversely related to obesity. This can be discussed in relation to the fact that such activities involve regular moderate- to vigorous-intensity exercise, which raises total energy expenditure and supports a healthy balance of energy [46]. These kinds of sports combine both aerobic and anaerobic exercise, and they enhance cardiorespiratory fitness, muscle mass, and fat metabolism; hence, the amount of body fat is decreased [47]. From our point of view, active exercise performed regularly throughout the week will help a person keep moving regularly and will also restrict sedentary lifestyles, such as spending longer hours in front of screens, which is closely linked to obesity. This research revealed that walking or using a bicycle to go to school is linked to protection against obesity. These results agreed with previous studies which discovered that adolescents who walked or cycled to school were less likely to be obese than those who did not actively commute [48, 45]. Our study found that those who sleep less than 8 hours are more likely to be obese compared to students who sleep 8 hours or more. These results were comparable with [32], which found similar results. This can be explained by the fact that lack of enough sleep interferes with major hormonal and metabolic activities that control appetite and energy balance. Lack of sleep causes elevation of ghrelin, the hunger hormone, and reduction of leptin, the satiety hormone, which makes one feel hungrier, especially for high-calorie foods [49]. Moreover, sleep deprivation leads to fatigue, lack of physical exercise, and increased sedentary activities such as screen time. It also influences glucose metabolism and insulin sensitivity, which encourages the gain of extra weight [50].In this study, those who eat 3 meals or more a day are more likely to be obese compared to students who eat fewer than 3 meals a day. These results agreed with the study findings conducted in Baghdad, Iraq [40], which found that more meals per day were associated with increased obesity. A similar study found that participants who ate 3 meals or more were linked with the development of obesity compared to those who ate fewer meals a day [12]. We can discuss that increased meal frequency results in increased daily caloric consumption as opposed to balanced dieting. Frequent eating in adolescents is associated with snacking, increased portion sizes, and eating energy-dense foods, and can lead to a positive energy balance and subsequent weight gain.

5 Conclusions and Recommendations

The study in Mosul identified a concerning prevalence of overweight and obesity (31%) among secondary school students, with boys showing a higher prevalence of obesity. The study identified family history, dietary choices, physical activity levels, occupational levels of both parents, higher income, higher socioeconomic status, sleeping less than 8 hours, and frequent meals as significantly associated with an increase in obesity. The study recommends the implementation of a variety of interventions in schools and communities to promote healthy lifestyles. Nutritional education programs, healthier food options in school canteens, more opportunities for physical activity throughout the school day, and public health campaigns to raise awareness of obesity and promote healthy behaviors among teenagers and their families are a few examples of these interventions. The study also highlights the need for more research to examine certain social, cultural, and economic variables that raise the risk of obesity in Iraqi teenagers.

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