Fast Food, Carbonated Drinks, and Socioeconomic Status Predict BMI among School Children in Benghazi: A Cross-Sectional Study

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Abstract

Background The effect of fast food, carbonated drinks, and socioeconomic status on BMI among school children in Benghazi.

Aim This article determines the prevalence of obesity and overweight and their relationship with environmental factors among children aged 7 to 12 years at a primary school in Benghazi, Libya.

Methods This cross-sectional study was conducted from October to November 2023 across primary schools in Benghazi, Libya, involving children aged 7 to 12 years ($n = 384$). Data were collected via a structured questionnaire: researcher staff recorded demographics and anthropometrics (height and weight using standardized protocols), while parents reported lifestyle factors (diet, physical activity, socioeconomic status). Body mass index (BMI) was calculated (kg/m^2), and associations were analyzed using chi-square tests (SPSS v23; $p < 0.05$). Ethical approval was obtained, with written parental consent and anonymized data.

Results This study revealed comparable obesity rates between genders, with 28.1% of boys (54/192) and 27.2% of girls (52/191) classified as obese, with no significant association between gender and BMI (chi-square = 0.18, $p = 0.981$). Significant relationships were found between obesity and key modifiable risk factors: frequent fast food consumption (chi-square = 56.32, $p < 0.001$), high carbonated beverage intake (chi-square = 142.07, $p < 0.001$), physical inactivity (chi-square = 23.4, $p = 0.001$), and higher family financial status (chi-square = 23.41, $p < 0.001$). Obese children exhibited extreme patterns of sedentary behavior (90.6% inactive) and sugary drink consumption (90.6% $\geq$ 3 times/week). A socioeconomic paradox emerged, with obesity prevalence highest in wealthier families while underweight status was associated with poorer economic conditions.

Conclusion The high prevalence of childhood obesity in Benghazi, surpassing rates reported internationally, underscores an urgent public health crisis driven by modifiable dietary and lifestyle factors. These include eating too much fast food and sugary

Keywords
- obesity
- primary school students
- prevalence
- Benghazi
- cross-sectional study

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drinks, not getting enough exercise, and unhealthy eating habits in wealthier families. These problems can be fixed through limiting junk food, making sure that kids are active every day, and teaching healthy eating habits. If we take these steps now, we can help children in Benghazi grow up healthier.

المقالة باللغة العربية

الوجبات السريعة والمشروبات الغازية والحالة الاجتماعية والاقتصادية تتنبأ بمؤشر كتلة الجسم لدى تلاميذ المدارس في بنغازي: دراسة مقطعية

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الخلفية: تُعد سمنة الأطفال تهديداً صحياً متزايداً في العالم أجمع، تتأثر بعوامل جينية ونمط حياة وبيئة، مما يؤدي إلى مضاعفات صحية جسدية ونفسية خطيرة .

الهدف: هدفت هذه الدراسة إلى تحديد معدل انتشار السمنة والوزن الزائد وعلاقتهما بالعوامل البيئية بين الأطفال بعمر 7-12 سنة في مدارس الابتدائية في بنغازي .

الطرق: أُجريت هذه الدراسة المقطعية من أكتوبر إلى نوفمبر 2023م في عدة مدارس ابتدائية ببنغازي، ليبيا، وشملت أطفالاً تتراوح أعمارهم بين 7-12 سنة (العدد=384). جُمعت البيانات عبر استبيان منظم: سجل الباحثون البيانات الديموغرافية والقياسات الجسمية (الطول، الوزن باستخدام بروتوكولات معيارية)، بينما أفاد الآباء بعوامل نمط الحياة (النظام الغذائي، النشاط البدني، الحالة الاجتماعية والاقتصادية). حُسب مؤشر كتلة الجسم (كجم/م²)، وحُللت العلاقات باستخدام البرنامج الإحصائي (SPSS)الإصدار 23؛ حددت العلاقة ما بين السمنة والعوامل البيئية القابلة للتغيير باستخدام اختبار كاي مربع وحددت القيمة الاحتمالية عند P<0.05.

النتائج: كشفت الدراسة عن معدلات سمنة متقاربة بين الجنسين، حيث كان 28.1% من الأولاد (192/54) و27.2% من البنات (191/52) مصنفين كأطفال يعانون من السمنة، دون وجود ارتباط ذي دلالة إحصائية بين الجنس ومؤشر كتلة الجسم (χ^2=0.18)، القيمة الاحتمالية=0.98. وُجدت علاقات ذات دلالة إحصائية بين السمنة والعوامل البيئية القابلة للتغيير، مثل: الاستهلاك المتكرر للوجبات السريعة (χ^2=56.32)، (القيمة الاحتمالية<0.001) وتناول المشروبات الغازية بكثرة (χ^2=142.07)، (القيمة الاحتمالية<0.001)، وقلة النشاط البدني (χ^2=23.4) ، (القيمة الاحتمالية<0.001)، وارتفاع المستوى المالي للأسرة (χ^2=23.41) ، (القيمة الاحتمالية <0.001). أظهر الأطفال المصابون بالسمنة معدلات عالية7 من الخمول (90.6% غير نشطين) واستهلاك المشروبات السكرية (90.6% ≤3 مرات/أسبوع). كما برز تناقض اجتماعي اقتصادي، حيث ارتبطت أعلى معدلات السمنة بالأسر الأكثر ثراءً، بينما ارتبط نقص الوزن بالظروف الاقتصادية الأضعف .

الاستنتاج: يؤكد ارتفاع معدل انتشار السمنة لدى الأطفال في بنغازي، الذي يتجاوز المعدلات المبلغ عنها دوليا، أزمة صحية عامة ملحة مدفوعة بعوامل غذائية ونمط حياة قابلة للتعديل. وتشمل هذه تناول الكثير من الوجبات السريعة والمشروبات السكرية، وعدم ممارسة التمارين الرياضية بشكل كاف، وعادات الأكل غير الصحية في العائلات الأكثر ثراء.

الكلمات المفتاحية: السمنة، تلاميذ المدارس الابتدائية، الانتشار، بنغازي، دراسة مقطعية.

Introduction

Overweight and obesity are defined as unusual or excessive fat build up that poses a health concern. A body mass index (BMI) of 25 or higher is deemed overweight and a BMI of 30 or higher is considered obese. In 2019, it was anticipated that higher-than-optimal BMI contributed to 5 million deaths from noncommunicable diseases (NCDs).[1]

Growth references for defining overweight and obesity differ by age group: The World Health Organization 2007 standards classify overweight as BMI $\geq$ 1 standard deviation (SD) and obesity as BMI $\geq$ 2 SD above the median for ages 5 to 19 years. The United States Centers for Disease Control and Prevention growth charts use $>$ 85th to $<$ 95th percentile for overweight and $\geq$ 95th percentile for obesity in children aged 2 to 20 years.[2]

Childhood overweight and obesity represent a serious global public health concern, associated with significant physical and psychological consequences in both childhood and adulthood.[3] While the prevalence of childhood obesity remains stable in high-income countries,[4] it continues to rise in low- and middle-income countries.[3,4] In 2013, an estimated 42 million children under 5 were overweight, with nearly 31 million residing in developing nations.[5] By 2016, obesity prevalence among children aged 2 to 19 years exceeded 30% in several Pacific Island countries and was above 20% in many Middle Eastern and North African regions.[6]

The primary causes of the rapid global rise in obesity rates lie in the profound environmental and societal changes now affecting large parts of the world and creating societies in which physical activity is low and the availability of high-fat, energy-dense foods has increased.[7]

Although the precise mechanisms driving obesity remain incompletely understood, the condition fundamentally arises from an imbalance between energy intake and expenditure. No single factor explains the rising global prevalence, as this imbalance stems from multiple etiologies. Genetic predisposition influences a child's susceptibility to obesogenic environments, but behavioral, cultural, and environmental factors are key drivers of the epidemic.[8] School-aged children face heightened risk due to prolonged sedentary behavior during classes and frequent exposure to unhealthy diets. In rare cases, obesity results from genetic disorders (e.g., leptin deficiency), endocrine conditions (e.g., hypothyroidism, growth hormone deficiency), or medication side effects (e.g., steroids).[8]

Furthermore, childhood overweight and obesity profoundly impact physical and psychological health, increasing risks for hyperlipidemia, hypertension, insulin resistance, and infertility. These children also face heightened susceptibility to psychological disorders, particularly depression. Without intervention, obese children often remain obese into adulthood, predisposing them to early-onset NCDs like diabetes and cardiovascular conditions.[9,10]

Effective prevention strategies require accurate assessments of childhood obesity's burden—especially in regions where cultural perceptions equate overweight with health.[11]

Libya is no exception to the global childhood obesity epidemic. Over the past decade, international studies have reported rising obesity rates across diverse populations, with varying geographic scope—from multiprovince analyses to city-specific assessments.[12] In Benghazi, alarming data by Elsaid et al revealed high obesity prevalence among Libyan children aged 4 to 19, affecting both sexes equally,[13] linking it to westernized diets, low physical activity, and familial factors like parental obesity and maternal education level.

This study was conducted to determine the prevalence of obesity among primary school children in Benghazi, Libya, and examine its associations with modifiable lifestyle factors (dietary habits, physical activity) and socioeconomic status (SES), while assessing potential gender differences.

Methods

Study Design and Setting

This cross-sectional study was conducted from October to November 2023 in primary schools across Benghazi, Libya. The study population consisted of children aged 7 to 12 years attending both public and private schools. Children with chronic illnesses or those receiving corticosteroid/growth hormone therapy were excluded from participation.

Sampling Technique

We employed a cluster sampling method, selecting one school from each of Benghazi's four administrative districts. From each school, we recruited 96 students (total $n = 384$), systematically selected as the middle three desk-sitters from each classroom row to ensure representative sampling.

Data Collection

Data were collected using a structured two-part questionnaire as seen in the ►**Appendix 1**. The first section, completed by research staff, recorded demographic information (age, gender, grade) and anthropometric measurements. The second section, completed by parents, assessed lifestyle factors including:

- Frequency of fast food and carbonated beverage consumption per week.
- Physical activity levels (categorized as active [> 3 sessions/week], moderate [1–3 sessions/week], or inactive [< 1 session/week]).
- Family SES categorized as bad (salary less than 1,000 Libyan Dinar/month), moderate (salary between 1,000 and 2,000 Dinar/month), and good financial status (salary more than 2,000 Libyan Dinar/month).

Anthropometric Measurements

Trained researchers conducted all measurements using standardized protocols:

- Height was measured to the nearest 0.5 cm using a wall-mounted stadiometer, with participants standing barefoot in the Frankfurt plane position
- Weight was measured to the nearest 0.5 kg using calibrated digital scales, with participants wearing light clothing
- BMI was calculated as weight (kg)/height (m^2)

Statistical Analysis

Data were analyzed using SPSS version 23. Descriptive statistics included frequencies (percentages) for categorical variables and means ± SDs for continuous variables. Chi-square tests were used to examine associations between variables, with statistical significance set at $p < 0.05$.

Ethical Aspects

We obtained verbal consent from the administration of the schools participating in the study. Written consent was taken from parents of children participating in this study. And ethical approval from the Libyan International Medical University Ethical Committee was obtained.

Result

A total of 383 students were included in this study, 192 males and 191 females, 50.1 and 49.9%, respectively (►**Table 1**). The mean age of the students was 9.5 (± 1.7 SD) years.

The study revealed significant findings regarding BMI distribution among primary school children in Benghazi (►**Table 1**). The combined prevalence of overweight (31.6%) and obesity (27.7%) accounted for nearly 59% of

Table 1 Association between BMI and gender in pediatric participants

BMI	Male		Female		Total		Chi-square	*p*-Values
	No	%	No	%	No	%		
Underweight	16	8.3	15	7.9	31	8.1	0.18	0.981
Normal weight	64	33.3	61	31.9	125	32.6		
Overweight	58	30.2	63	33	121	31.6		
Obese	54	28.1	52	27.2	106	27.7		
Total	192		191		383			

Abbreviation: BMI, body mass index.

Table 2 Association between BMI and family financial state in pediatric participants

BMI	Bad		Moderate		Good		Chi-square	*p*-Values
	No	%	No	%	No	%		
Underweight	14	45.2	12	38.7	5	16.1	23.4	0.001
Normal Weight	48	38.4	35	28	42	33.6		
Overweight	26	21.5	35	28.9	60	49.6		
Obese	29	27.3	36	34	41	38.7		
Total	117	30.6	118	30.8	148	38.6		

Abbreviation: BMI, body mass index.

Table 3 Association between BMI and fast food consumption/week in pediatric participants

BMI	Once		Twice		Three+		Chi-square	*p*-Values
	No	%	No	%	No	%		
Underweight	12	38.7	14	45.2	5	16.1	56.4	0.001
Normal Weight	66	52.8	31	24.8	28	22.4		
Overweight	25	20.7	32	26.4	64	52.9		
Obese	17	16	41	38.7	48	45.3		
Total	120	31.3	118	30.8	145	37.9		

Abbreviation: BMI, body mass index.

Table 4 Association between BMI and carbonated beverage consumption/week in pediatric participants

BMI	Once		Twice		Three+		Chi-square	*p*-Values
	No	%	No	%	No	%		
Underweight	2	6.45	17	54.8	12	38.7	142.4	0.001
Normal Weight	44	35.2	43	34.4	38	30.4		
Overweight	11	9.1	39	32.2	71	58.7		
Obese	0	0%	10	9.4	96	90.6		
Total	57	15.03	109	28.46	217	56.66		

Abbreviation: BMI, body mass index.

the study population ($n = 383$), while normal weight children represented 32.6% and underweight cases were least common at 8.1%. Gender-based analysis showed remarkably similar patterns between males and females, with slightly higher overweight prevalence among girls (33% vs. 30.2%) and marginally greater obesity rates among boys (28.1% vs. 27.2%). The chi-square test indicated no statistically significant differences in BMI distribution between genders ($p > 0.05$).

A significant association was found between children's BMI and family financial status (chi-square = 23.41, $p < 0.001$) (►**Table 2**). Underweight children were most prevalent in families with "bad" financial status (45.2%), while overweight and obesity showed higher proportions in families with "good" financial status (49.6 and 38.7%, respectively). Normal weight children were relatively evenly distributed across financial groups.

A highly significant association was observed between children's BMI categories and frequency of fast food consumption (chi-square = 56.32, $p < 0.001$) (►**Table 3**). The data revealed a clear dose–response relationship, with normal weight children showing the highest proportion of eating fast food only once weekly (52.8%), while overweight and obese children demonstrated substantially higher frequencies of consuming fast food three or more times weekly (52.9 and 45.3%, respectively). Underweight children showed an intermediate pattern, with most consuming fast food twice weekly (45.2%).

►**Table 4** shows a strong association between children's BMI categories and frequency of carbonated beverage consumption (chi-square = 142.07, $p < 0.001$). A pattern emerged where obese children showed dramatically higher consumption, with 90.6% drinking carbonated beverages three or more times per week, compared with just 38.7% of underweight children. Normal weight children displayed an intermediate pattern, with more balanced consumption across categories (35.2% once, 34.4% twice, and 30.4% three+ times weekly).

►**Table 5** shows a highly significant association between BMI categories and physical activity levels (chi-square

Table 5 Association between BMI and physical activity/week in pediatric participants

BMI	Active		Moderate		Nonactive		Chi-square	*p*-Values
	No	%	No	%	No	%		
Underweight	2	6.45	17	54.8	12	38.7	23.4	0.001
Normal Weight	44	35.2	43	34.4	38	30.4		
Overweight	11	9.1	39	32.2	71	58.7		
Obese	0	0	10	9.4	96	90.6		
Total	57	15.03	109	28.46	217	56.66		

Abbreviation: BMI, body mass index.

$= 23.4$, $p = 0.001$). A clear inverse relationship was observed, where normal weight children showed the highest proportion of active individuals (35.2%), while obese children had no active participants (0%). Physical inactivity dramatically increased with BMI, reaching 90.6% in obese children compared with 38.7% in underweight and 30.4% in normal weight groups. Overweight children displayed an intermediate pattern, with 58.7% being nonactive.

Discussion

Many children suffer from severe obesity, which is a major public health concern. Obesity must be handled through a variety of strategies, ranging from early prevention of overweight and obesity to treatment of individuals in need, due to the influence it has on the educational, health, social care, and economic systems.[14]

In the present study, the overall prevalence of obesity among children aged 7 to 12 years was 28%, which is notably higher than the rate reported in a previous study conducted in the same city (Benghazi) by Amina et al (20.6%).[13] This upward trend suggests a worsening childhood obesity epidemic in the region, possibly driven by urbanization, dietary shifts, and reduced physical activity.

Compared with international studies, our findings reveal significantly higher obesity rates than those reported in Port Said, Egypt (13.5%),[16] India (11.7%),[17] Tanzania (6.7%),[18] and Serbia (6.9%).[19] These disparities may reflect differences in socioeconomic transitions, food environments, and cultural practices. However, our results align closely with data from Iran (Emamian et al), where 25.7% of children were overweight or obese,[20] suggesting that the Middle Eastern/North African countries may share similar obesogenic risk profiles.

In this study, the prevalence of overweight and obesity showed no significant gender differences (chi-square test, $p = 0.951$). This contrasts with studies from Qatar, where obesity/overweight was more prevalent in males,[20] and other global reports suggesting higher overweight rates in females, potentially due to hormonal, behavioral, or environmental factors.[17,21] However, our findings align with Iranian data showing no significant sex-based differences in obesity/overweight prevalence.[22]

This study found a significant association between higher SES and increased childhood obesity ($p < 0.028$), reinforcing the nutrition transition paradox where wealthier families showed greater obesity prevalence while undernutrition was more common in poorer households. These findings align with similar patterns observed in Egypt[15] and global trends,[23] likely reflecting greater access to energy-dense foods, reduced physical activity, and cultural perceptions of abundance in higher SES groups within urban Benghazi. The results underscore the dual burden of malnutrition in Libya's developing urban context and highlight the urgent need for SES-sensitive interventions that address obesogenic environments while simultaneously tackling undernutrition in lower-income populations.

This study reveals a robust dose-dependent relationship between fast food intake and childhood obesity (chi-square $= 56.32$, $p < 0.001$; Cramer's $V = 0.38$), with overweight/obese children consuming fast food $\geq 3\times$/weekly at substantially higher rates (52.9 and 45.3%, respectively) compared with normal weight peers (52.8% once weekly). These findings align with global evidence linking processed foods and sugar-sweetened beverages to elevated BMI,[24] and mirror decade-long trends showing junk food-driven overweight increases (9.7%→13.9%). The observed gradient—where fast food frequency escalates with BMI category—underline its role as a modifiable obesity driver in Benghazi's schoolchildren. Notably, underweight children exhibited intermediate consumption patterns (45.2% twice weekly), suggesting dual nutritional risks in this population: undernutrition coexisting with obesogenic dietary habits. This evidence calls for urgent school-based nutrition policies targeting processed food accessibility and dietary education.

A striking dose–response relationship emerged between sugary drink intake and BMI (chi-square $= 142.07$, $p < 0.001$), with 90.6% of obese children consuming carbonated beverages $\geq 3\times$/weekly versus only 6.45% of underweight children reporting minimal intake (once weekly). This pattern—where soda consumption frequency escalates progressively across BMI categories—mirrors global evidence linking sugar-sweetened beverages to obesity.[24] The near-absence of obese children in the lowest consumption category underline carbonated drinks as a critical modifiable risk factor in Benghazi's childhood obesity epidemic. Notably, even underweight children showed moderate consumption patterns (38.7% $\geq 3\times$/weekly), suggesting pervasive exposure to unhealthy dietary habits across all nutritional statuses. These findings warrant urgent policy attention to restrict

school-based soda availability and promote water consumption.

This study revealed a highly significant association between physical inactivity and childhood obesity (chi-square $= 23.4$, $p = 0.001$), with 90.6% of obese children classified as sedentary (vs. 30.4% of normal weight peers). These findings align with prior evidence from Benghazi,[13] where 78.5% of children reported no regular exercise, coupled with excessive screen time—a pattern strongly linked to obesity risk. The dose-dependent relationship (inactivity prevalence rising with BMI category) underline physical activity's dual role: protective against obesity in childhood and mitigating adult obesity risk.[25] Notably, even normal weight children showed suboptimal activity levels (35.2% active), suggesting population-wide behavioral risks. These results call for mandatory school-based physical education programs, community sports initiatives targeting sedentary behaviors, and screen time regulations to counter passive leisure trends.

Conclusion

This study revealed strong associations between childhood obesity in Benghazi and key lifestyle factors, including frequent consumption of fast food and carbonated beverages, higher family financial status, and physical inactivity. The findings highlight that obesity is significantly linked to modifiable dietary and activity patterns, emphasizing the need for targeted school-based interventions promoting healthy eating and regular exercise, particularly among children from higher socioeconomic backgrounds. Addressing these risk factors through public health strategies could help curb the growing obesity epidemic in this population.

Conflict of Interest
None declared.

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Appendix

Appendix 1: Questionnaire

The Prevalence of Obesity among Primary School Student in Benghazi Aged 7 to 12 Years

This study aims to measure the prevalence of obesity in children and identify factors that increase the risk of developing it. If you agree to participate in this study, please complete the following form. This data will not be used for purposes other than the study. Thank you for your cooperation.

Child's Age.....
Child's Gender.....

Measurements

Child's Weight.....
Child's Height.....
Child's Body Mass Index.....

BMI

- Under weight
- Normal
- Over weight
- Obese

Place of Residence
- ◦ Apartment
- ◦ House
- ◦ Villa

Number of Meal Deals Per Week
- ◦ Once
- ◦ Twice
- ◦ Three or More Times

If the Child's Drinking of Soft Drinks and Juices
- ◦ Once
- ◦ Twice
- ◦ Three or More Times

Does the Child Suffer from Any Diseases?
- ◦ No
- ◦ Yes

Does the Child Have Any Sports Hobbies (Soccer, Swimming, etc.)?
- ◦ No
- ◦ Yes

Number of Times the Child Participates in Sports Activities Per Week
- ◦ Once
- ◦ Twice
- ◦ Three Times

Evaluation of the Family's General Income Level
- ◦ 100–500
- ◦ 1000–2000
- ◦ $>$ 2000

