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# Prevalence of overweight, obesity, and associated risk factors in healthy female adolescents in Tehran, Iran

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## Abstract

**Introduction:** Obesity is an important health concern worldwide and is a growing problem in Iran. Adolescent obesity has a major role in development of adulthood obesity and its complications. The present study was conducted to evaluate the prevalence of overweight, obesity, and associated risk factors in female adolescents living in Tehran, Iran.

**Methods:** This cross-sectional study was carried out among 2,132 female adolescents aged 14-17 years in Tehran recruited between 2017 and 2018. Weight and height were measured and body mass index (BMI) was calculated. Underweight, overweight, and obesity were considered as < 5th, ≥ 85th, and ≥ 95th percentile, respectively, of CDC BMI-for age and sex criteria. Adolescents and their mothers filled in the questionnaires on physical activity, computer use, duration of breastfeeding, total sleep time, and family socioeconomic status. Statistical analysis was performed using SPSS version 22.0 software. $P < 0.05$ was considered statistically significant.

**Results:** The overall prevalence rates of overweight and obesity were 24.1% and 6.5%, respectively. The prevalences of overweight and obesity were highest in the South District (28.9% and 7.7%, respectively) and were lowest in the North District (19.1% and 5.2%, respectively). There were significant differences in physical activity level ($P < 0.001$), total sleep time ($P < 0.001$), duration of breastfeeding ($P < 0.01$), and daily computer use ($P < 0.001$) among the four groups (underweight, normal, overweight, and obese). Regarding the socioeconomic status, parental education level and economic status were significantly higher in those who had normal weight compared to other weight groups (in both, $P < 0.001$).

**Conclusion:** This study showed that overweight and obesity among female adolescents in Tehranhave become a major public health concern. Level of physical activity, computer use, sleep duration, breastfeeding duration, levels of parental education, and economic status were associated with overweight and obesity prevalence.


**Keywords:** *Overweight; Obesity; Body mass index; Female adolescents; Tehran*

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## Research

### Introduction

The epidemic of overweight is a growing worldwide public health concern.[1] It is well established that obesity elevates the risk of cardiovascular diseases, diabetes, hyperlipidemia, and musculoskeletal disorders in adults.[2] Recent studies have indicated that obesity in adolescence is a strong risk factor for obesity and associated morbidity in adulthood, with 50% to 80% of obese adolescents becoming obese adults.[3]

On the other hand, in many developing countries undergoing epidemiologic transition, the double burden of malnutrition and overweight co-occur.[4]

Although, the contribution of heredity factors may account for about 30-70% of obesity,[5] the intake of high calorie food and decreased expenditure of energy,

changing lifestyle and behaviors, also contribute to the overweight and obesity epidemic. Breastfeeding is one of the earliest initial prevention measures that can be implemented to decrease the rates of childhood obesity. Previously published studies show a 26% reduction in the risk of being overweight or obese in later life of children who were breastfed compared to those were formula fed.[6,7] In addition, prior studies indicate that sleep insufficiency elevates the risk of overweight and obesity. While the mechanisms are not well understood, sleep insufficiency may lead to hormonal alterations, less physical activity, and to unhealthy eating patterns including elevated consumption of foods with a high glycemic index.[8] Socioeconomic factors also have a notable effect on adolescent weight, since it has been demonstrated that populations with low economic level have a higher prevalence of childhood obesity, due to diet, which is mainly based on a high intake of carbohydrates that were established to be the most easily obtainable foods for their environment.[8]

To our knowledge, studies evaluating the trends of overweight and obesity among adolescents in Tehran are scarce. Hence, the present study was designed to investigate the prevalence rates of overweight, obesity, and associated risk factors in female adolescents aged 14-17 years in Tehran, Iran.

## Methods

*Study design, subjects, and sampling*

This cross- sectional study was conducted among female adolescents, aged 14-17 years, enrolled in high schools in Tehran, the capital city of Iran, in 2017-2018. The sample of 2,132 female adolescents were enrolled based on sample size calculation with presumption of 6% obesity prevalence.[9]

We classified the study location as North, East, Central, West, and South, according to 19 educational districts of Tehran city. A random sample of 2,132 female adolescents was selected in a multi- stage sampling technique from the governmental supported public high schools. Female adolescents, healthy (not suffering from any chronic and acute disease), and aged 14-17 years were eligible for the study. Adolescents who were taking laxative or hormonal medications, who did not give signed informed consent by parents or by themselves, refused to participate, and those with physical disabilities were not investigated.

Mothers were invited to schools by an invitation letter. The aims and methodology of the research were explained to them by the members of the research team, and written consents was obtained from adolescents and their parents. This study was approved by the Ethics Committee of Iran University of Medical Sciences (Tehran, Iran).

*Anthropometric measurements and data collection*

Weights and heights of the participants were measured by the trained nutritionists using the same standard tools. Height was measured to the nearest 0.1 cm, in standing position and without shoes, using a fixed tape meter. Weight was measured using a portable Beurer scale (Beurer, Germany) with minimum clothing and without shoes to the nearest 0.1 kg. Body mass index (BMI) was computed by using the formula.

Based on CDC criteria, female adolescents with BMI-for-age and sex at or above the 95th percentile, between 85th and 95th percentile and less than 5th percentile were considered as being obese, overweight, and underweight, respectively.[10]

Designed questionnaires were used to collect demographic and lifestyle data, age, physical activity level, total sleep time, daily computer use, and duration of breastfeeding from students, while socioeconomic status of participants were obtained from their mothers. Physical activity level was investigated by the Persian and the International Physical Activity Questionnaire (IPAQ) short form and expressed as Met-Min/week.[11]

| Variable | Value | Min | Max |
|---|---|---|---|
| Age (years)[a] | 15.50 ± 1.06 | 14.00 | 17.00 |
| Height (cm)[a] | 160.38 ± 6.39 | 140.00 | 185.00 |
| Weight (kg)[a] | 59.66 ± 13.00 | 21.30 | 104.70 |
| BMI (kg/m$^2$)[a] | 23.14 ± 4.61 | 15.00 | 40.10 |
| Physical activity (Met-Min/week)[b] | 730.00 (644.50) | 234.00 | 2023 |
| Sleep duration (hours)[b] | 7.00 (3.00) | 3.00 | 9.00 |
| Computer using time (minute)[a] | 90.49 ± 37.43 | 30.00 | 240.00 |
| Breastfeeding duration (month)[b] | 6.00 (7.00) | 0.00 | 24.00 |

[a] Values are described as mean±SD

[b] Values are described as Median (Interquartile)

**Table 1**. Characteristics of the participants

The socioeconomic status (SES) of the adolescents was obtained from their mothers, using an economic indicator on the presence or absence of private bedroom, personal computer, automobile and travelling on holidays. According to this scale, three economic groups were idetified: low, medium, and high. Educational levels of parents were investigated as a social factor (primary, secondary, or university). This socioeconomic frame has been commonly used in Iran.[12] Total sleep time (in hours), daily computer use (in minutes), and duration of breastfeeding (in months) were assessed by the questionnaire.

*Statistical analysis*

Statistical analysis was performed by using SPSS version 22.0 (SPSS, Inc, Chicago, Illinois) software. All continuous variables had normal distribution except for physical activity, duration of breastfeeding, and total sleep time. Data were shown as mean±SD, unless expressed otherwise. Categorical variables are reported as frequencies and percentages. Chi-square test was used to evaluate the differences between categorical variables. Analysis of variance (ANOVA) was used to identify differences between the four groups (underweight, normal, overweight, and obese) for continuous variables. Comparison of non-normally distributed data was performed using Kruskal-Wallis test. In addition, we applied ordinal logistic regression analysis to estimate the determinatives of overweight and obesity. $P < 0.05$ was considered statistically significant.

## Results

This report is based on data from 2,132 female adolescents aged 14-17 years in Tehran, Iran, enrolled between 2017 and 2018. The characteristics of the study participants who were recruited in this study are shown in Table 1.

The prevalence rates of underweight, overweight and obesity are demonstrated in Table 2. The overall prevalence of underweight, normal, overweight, and obesity were 14.3, 55.2, 24.1, and 6.5%, respectively. The proportions of overweight and obesity were highest in the South District (28.9 and 7.7%, respectively) and were lowest in the North District (19.1 and 5.2%, respectively). The proportion of underweight was highest



| | Normal | Underweight | Overweight | Obese | Total |
|---|---|---|---|---|---|
| **District, n (%)** | | | | | |
| North | 110 (63.6) | 21 (12.1) | 33 (19.1) | 9 (5.2) | 173 |
| East | 365 (58.6) | 86 (13.8) | 135 (21.7) | 37 (5.9) | 623 |
| Central | 147 (55.5) | 36 (13.6) | 65 (24.5) | 17 (6.4) | 265 |
| West | 289 (59.5) | 55 (11.3) | 112 (23.0) | 30 (6.2) | 486 |
| South | 265 (45.3) | 106 (18.1) | 169 (28.9) | 45 (7.7) | 585 |
| **Total, n (%)** | 1176 (55.2) | 304 (14.3) | 514 (24.1) | 138 (6.5) | 2132 |

**Table 2**. Prevalence of overweight and obesity in female adolescents

in the South District (18.1%) and was lowest in the West District (11.3%).

No significant differences were seen between the four groups (underweight, normal, overweight, and obese) in age and height in each district and overall in the city ($P \geq 0.05$). There were significant differences in regards to physical activity level ($P < 0.001$), total sleep time ($P < 0.001$), duration of breastfeeding ($P < 0.01$), and daily computer use ($P < 0.001$), among the four groups in each district and overall city.

There were significant differences in economic status among the four groups (underweight, normal, overweight, and obese) ($P < 0.001$). The percentage of low economic status was highest in obese group (44.2%), and both percentages of medium (68.5%) and high (22.4%) economic states were highest in normal group (Table 3).

Significant differences were observed in both mothers' and fathers' educational level, between the four groups (underweight, normal, overweight, and obese) ($P < 0.001$) (Table 3). The proportion of mother's primary educational level as the maximum education achieved was highest in underweight group (36.0%), and both proportion of mother's secondary and university education level (67.5 and 21.5%, respectively) were highest in normal group (Table 3). Regarding the father's education level, the proportion of primary education level was highest in underweight group (33.9%), and the highest proportions of secondary and university education levels were seen in overweight (59.5%) and normal (34.9%) groups, respectively (Table 3).

Ordinal logistic regression analysis, physical activity, daily computer use, total sleep time, duration of breastfeeding, economic status, and mothers' and fathers' educational level were significant predictors of weight status in female adolescents ($P < 0.001$).

## Discussion

The findings of the present study indicate that the overall prevalence rates of underweight, normal, overweight, and obesity in 14-17 years old female adolescents in Tehran are 14.3, 55.2, 24.1, and 6.5%, respectively, with the highest prevalence of overweight and obesity in the lowest socioeconomic district (South). The results of the current study are different from the findings reported from other geographical areas of Iran. In a study among the female adolescents aged 15-18 years in Najafabad highschools (Najafabad, Iran) in 2011, the overall prevalence rates of underweight, overweight, and obesity were 10.6, 20.5, and 6%, respectively.[9] The higher rates of overweight

| Variable | Normal (n=1,176) | Underweight (n=304) | Overweight (n=514) | Obese (n=138) | *P** |
|---|---|---|---|---|---|
| **Economic status** | | | | | < 0.001 |
| Low, n (%) | 107 (9.1) | 88 (28.9) | 164 (31.9) | 61 (44.2) | |
| Middle, n (%) | 805 (68.5) | 184 (60.5) | 309 (60.1) | 68 (49.3) | |
| High, n (%) | 264 (22.4) | 32 (10.5) | 41 (8.0) | 9 (6.5) | |
| **Maternal education level** | | | | | < 0.001 |
| Primary, n (%) | 129 (11.0) | 109 (36.0) | 89 (17.3) | 43 (31.2) | |
| Secondary, n (%) | 793 (67.5) | 157 (51.8) | 346 (67.3) | 71 (51.4) | |
| University, n (%) | 252 (21.5) | 37 (12.2) | 77 (15.0) | 24 (17.4) | |
| **Paternal education level** | | | | | < 0.001 |
| Primary, n (%) | 67 (5.7) | 103 (33.9) | 122 (23.7) | 36 (26.1) | |
| Secondary, n (%) | 698 (59.4) | 166 (54.6) | 306 (59.5) | 66 (47.8) | |
| University, n (%) | 411 (34.9) | 35 (11.5) | 86 (16.7) | 36 (26.1) | |

*Chi-square test.

Table 3. Comparison of the socioeconomic variables in the participants in BMI groups

and obesity in our study may be attributed to the differences in sample size, socioeconomic status, physical activity level, or eating habits. In another study between 2,900 students (1,200 males and 1,700 females) aged 11-17 years in Tehran (2004-2005), prevalence of overweight and obesity were 17.9 and 7.1%, respectively.[13] In another investigation, among a sample of 398 students (199 girls and 199 boys) aged 10-15 years in Tehran (2000-2001), overall prevalence of overweight and obesity were 16 and 10%, respectively.[14] In the investigation the prevalence of overweight in girls (19%) was higher than that in boys (14%), but the prevalence rate of obesity among boys (13%) was two times as many as girls (6.5%).[14]

Similar to the increasing trend in adults, the proportions of overweight and obesity have elevated notably since 1980 among children and adolescents worldwide.[1,15] But the prevalence of overweight and obesity among adolescents in other parts of the world differs based on the geographical region. Available data demonstrated that roughly 33.8% of adolescent girls aged 12-19 years were overweight and obese and 20.7% were obese in 2011-2012, based on CDC criteria, in the United States.[16] In China, the China Health and Nutrition Survey findings indicated that 8.0% of adolescent girls aged 15-18 years were overweight/obese in 2011.[17]

Obesity definition, the age of participants, and the time when the participants were evaluated vary in

studies describing the prevalence of obesity, making it difficult to compare the rate of overweight and obesity among existing studied populations.

Hence, according to the findings of our investigation and similar studies,[9,13,18-20] overweight and obesity should be considered as serious public health challenges at the national level in Iran.[20]

There was a significant difference in physical activity level between the four groups (underweight, normal, overweight, and obese), with the highest level among normal weight and the lowest in obese groups. In addition, a significant difference was observed between the four groups in term of the times spent on computer, with the highest duration among underweight and the lowest in overweight adolescents.

Similar to our results, another study with the aim of determining the prevalence of overweight/obesity in relation to lifestyle among 7-17 years old children and adolescents in Lithuania, reported that time spent on the computer or TV during the week was not related to being overweight/obesity.[2]

We hypothesize that absence of the direct association between the overweight/obesity and computer use does not reflect the other side of overweight/obese adolescent inactivity: these adolescents might have inactive hobbies (music, art, etc) contrary to normal weight and underweight counterparts who could be took part in more active hobbies including tennis, swimming, etc. Previously demonstrated that overweight/obese children are more active and report more screen duration than normal weight ones.[21] This notion is in line with earlier report of Nitzan Kaluski et al, who did not show any association between time spent at the computer, watching TV or videos, or listening to music on physical inactivity and obesity.[22] Another justification could be a direct kind of the question in the questionnaire (computer use), which does not encompass other gadgets use (tablets, smart phones, consoles, etc.).

As proposed by some researchers, a negative impact of computer/TV use may be related to an elevated intake of sweets and snacks, both because of an effect on altering eating behavior and of higher exposure to advertisements of food high in sugar and fat.[23,24]

In addition, physical inactivity seems to be both a cause and a consequence of obesity.[25]

We found a significant difference in duration of breastfeeding between the four groups (underweight, normal, overweight, and obese), with the highest duration in normal weight. Prior studies have investigated the association between infant feeding and overweight and obesity, with different results.[26-31] The studies that indicated no relationship had comparatively smaller sample sizes, were frequently not population- based, and limited to young aged groups ranging from 6-8 month old infants. In contrast, some other investigations indicated a strong and reverse association based on larger sample sizes.[32-34] In a study conducted by Fallahzadeh et al, among 800 school children aged 11-13 years, a reverse association between the duration of breastfeeding and overweight was reported.[35] Karmer et al. demonstrated a strong protective relationship of breastfeeding on obesity in two samples (clinic and schools) of more than 600 adolescents of 12-18 years old.[32]

Both behavioral and metabolic explanations for the observed relationship between breastfeeding and obesity have been suggested. Breast milk composition alters during feeding and makes satiety signals for the infant to stop suckling.[36] While in bottle-fed infants, the amount consumed is controlled mainly by volume, which may lead to overfeeding. Moreover, breastfed infants may obtain more control throughout their feeding behavior than bottle-fed ones.[37]

Bottle-fed infants indicate significant higher plasma levels of insulin and a prolonged insulin response.[38] This is in turn may prompt cell glucose uptake and suppress biolysis, hence leading to differences in deposition of subcutaneous adipose

tissue.[39] Odeley et al. have demonstrated that fasting insulin is positively related to weight gain and alter in triceps skin fold in a cohort of 5- to 9- year old Pima Indian children followed during 9 years, a finding confirmed in young adults aged 18-30 years.[40] The weight and fat gain stimulating impacts of insulin in young populations could therefore underlie the observed relationship of breastfeeding and overweight and obesity. Moreover, Ravelli et al. have reported that individuals aged 48-53 years who were exclusively breast fed over the first 10 days of life exhibit significantly lower fasting levels of insulin and glucose than those who were bottle fed.[41] They also have higher BMI, waist circumference and waist-to-hip ratio, which however, were not statistically significant.[37] In another study conducted by Mirzaeian et al. among female adolescents aged 15-18 years, it was reported that breastfeeding (without considering its duration) was significantly related to a decreased risk of overweight and obesity.[9] While, no statistically significant relationship was reported between duration of breastfeeding with overweight and obesity in the participants.[9]

Hence, our study showed that the duration of breastfeeding is reversely associated with the prevalence of overweight and obesity in female adolescents.

In the present study, there was a significant difference in total sleep time (during 24 hours) between the four groups (underweight, normal, overweight, and obese), with the highest sleep duration (6.98 ± 1.22) in normal weight group. This result is similar to the findings of the longitudinal study by Kim et al. among adolescents to evaluate the associations of sleep patterns, health outcomes, and health risk behaviors.[42] It was indicated that shorter sleep duration was related to obesity.[42] These results are corroborated by the reports indicating that shorter sleep time has contributed to the obesity epidemic.[43-47] Wheaton et al. indicated that short sleep duration was associated with unhealthy weight- control behaviors that can result to being obese.[47]

Our results propose that shorter sleep duration may be related to overweight or obesity. Several mechanisms that might connect inadequate sleep to higher BMI values have been suggested. It has been well established that inadequate sleep is related to lower levels of anorexigenic hormones, such as leptin, in contrast with increased serum concentrations of orexigenic hormones such as ghrelin.[48,49] Serum levels of cortisol also increased toward the evening in states of total and partial sleep insufficiency.[50] Cortisol has a lipogenic influence, which may lead to weight gain in chronic sleep insufficiency.[50] In addition, lower physical activity has been indicated as other mechanism that might lead to weight gain in those with insufficient sleep.[51] The results of another study propose that the relationship between sleep insufficiency and obesity may in part be the result of alterations in neuronal activity when exposed to food stimuli. These alterations apparently influence brain parts known to be connected to motivation and desire and may demonstrate an elevated tendency to eat food in those who are not getting sufficient sleep.[52]

In our study, there was a significant difference in economic status between the four groups (underweight, normal, overweight, and obese). Low economic status was more prevalent in obese group. While both, middle and high economic states were more frequent in normal weight group. Moreover, level of maternal and paternal education was higher in normal weight group. Family socioeconomic status has been indicated to be inversely associated with the prevalence of overweight and obesity,[53] with the highest prevalence of overweight being in the lowest socioeconomic groups.[23,54] Previous investigations indicated that higher levels of maternal or paternal education were related to the lower risk of being overweight in children. Finnish LATE study reported that paternal education had inverse relationship, mediated by parent's BMI, with overweight in older boys. However, maternal education indicated indirect relationship.[55] Level of parental education is a strong socioeconomic determinant associated with eating behaviors and screen time.[2] Children of less educated

parents with low income reported to consume nutrient-poor but calorie-dense beverages more frequently instead of nutrient-dense beverages.[56,57]

It is well known that the impact of SES on overweight and obesity differs in differently developed regions.[58,59]

The strengths of our study include the population- based approach, and a large sample size. The study was conducted by the same trained research team by using the same standard tools.

This study also has few limitations. First, the cross-sectional design, which can result in uncertainties regarding the temporality of cause and effect of the observed relationships, and self- reported responses, which are suspected to error and under- or over-reporting. Second, we did not evaluate dietary intake of the adolescents, as well as their parent's BMI. These factors may contribute to overweight and obesity. Parental history of obesity is one of the most important known risk factors for obesity in the offspring, more than doubling the risk.[60] Third, data on breastfeeding duration were collected based on mother's recall, which may be subjected to recall and/or reporting bias. Collecting data many years later may lead to misclassified exposures and subsequently incorrect conclusions. Forth, we evaluated only BMI as the measure of adiposity, but it does not differentiate fat and lean body mass.

In conclusion, the results of this study demonstrate that overweight and obesity among female adolescents in Tehran, Iran, is now a major public health challange. With respect to the findings, several factors such as level of physical activity, times spent on computer, sleep duration, breastfeeding duration, levels of parental education and economic status have important effects on weight gain. Hence, public health strategies are needed to combat with elevated rates of overweight, obesity, and subsequent complications in adolescents. More research on the risk factors is needed before preventive public health strategies can be developed and put into practice.

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