Physical activity and sedentary behaviors (screen time and homework) among overweight or obese adolescents: a cross-sectional observational study in Yazd, Iran

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Abstract

Background: The growing number of adolescents who are overweight or obese (OW / OB) is a public concern. The present study was aimed to evaluate physical activity (PA) and sedentary behaviors (SB) (screen time (ST) and homework time (HT)) among Yazd OW/OB adolescents.

Methods: This cross-sectional study was performed among 510 students aged 12-16 in Yazd, Iran. The general information, PA, and SB (ST and HT) were collected by interview based on the WHO standard questionnaire. Anthropometric data were assessed by precise instruments. Daily energy intake (Energy) was obtained from a 7-day food record. Nutritionist 4 software (version I) was run to estimate the energy.

Results: There was a high prevalence of SB > 2h/day (97.6), ST > 2h/day (70.3%), overweight or obesity (40%), abdominal obesity (36.9%), physical inactivity (29.8%) among the students. The younger age (p = 0.014), energy (p < 0.001), no access to the yard (p < 0.001), family size ≤ 2 (p = 0.023), passive transportation, (p = 0.001), the highest school days’ HT (p = 0.033) and SB (p = 0.021), and the highest weekends’ HT among the students were the risk factors for OW/OB. The highest PA level was associated with a lower risk of OW/OB (p < 0.001). The findings were not the same in both sexes. Compared to the normal weight students, OW / OB spent more time on school days and weekdays for ST (P <0.001), HT (P <0.001, P = 0.005) and SB (P <0.001), respectively. OW/OB students showed a higher weekends’ ST (p < 0.001) and lower HT (p = 0.048) than normal-weight students.

Conclusion: The prevalence of SB, ST, OW/OB, and physical inactivity were common. The school days and weekends’ HT, the school days’ SB and HT, age, energy, PA, and access to the yard, family size, and passive transportation were related to the greater chances of OW/OB students. Given that the expansion of online education and self-isolation in a new situation with COVID-19, it seems we will meet the worrying results.

Keywords: Overweight or obesity, Adolescents, Physical activity, Sedentary behaviors, Screen time

Background

Worldwide obesity among adolescents is on the rise. Obese adolescents are more likely to remain obese in adulthood [1]. The prevalence of overweight and obesity among children and adolescents aged 5-19 has risen more than 4 times from 1975 to 2016 with a similar rise among both boys and girls. According to a World Health
overweight or obesity had a more risk for higher watch -

Moreover, Iranian students with an unhealthy diet and

In Iranian girls and boys aged 13-18 years, respectively.

were observed

≥ 2h (10.31 and

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high ST) was shown a chance of overweight at nearly two

US youth with the inactive patterns (low PA along with

genders, the high ST was related to physical inactivity.

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≥

[6]. The prevalence of watching TV

high ST could be one of the risk factors of overweight/

Qataris had more ST during the weekdays and weekends,

than non-Qatari students. The Qatari students and non-

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had a more inactive pattern (physical inactivity and high

sexes, weekday ST, excessive use of smartphones during

Qatar from April 20, 2019, to June 3, 2019 (before the coro-

nation, and increasing urbanization [1]. A study showed

that more than 50% of the students (12-17 years) of the

resident in Qatar reported physical inactivity and high

screen time (ST) more than 2 hours (≥ 2h) on both week-

days and weekends. The prevalence of SB was higher on

the weekends than weekdays. Moreover, the girl students

had a more inactive pattern (physical inactivity and high

ST) than the boy students as well as Qatari students

than non-Qatari students. The Qatari students and non-

Qatari students had more ST during the weekdays and weekends,

respectively [4].

Watching TV/video/DVD and doing homework for

≥ 2h, and having insufficient physical activity (PA) were

related to Sri Lankan overweight adolescents aged 14-15

[5]. The prevalence of overweight or obesity and using

ST ≥ 2h/day between U.S children or adolescents (6-17

years) was high (35.3% and 44%, respectively). In both

genders, the high ST was related to physical inactivity.

US youth with the inactive patterns (low PA along with

high ST) was shown a chance of overweight at nearly two

times in compared to US youth with the active patterns

[6]. The prevalence of watching TV ≥ 2h (57.22 and 57.57
%

), using a personal computer (PC) ≥ 2h (10.31 and

18.07%), and low PA (39.34 and 34.5%) were observed

in Iranian girls and boys aged 13-18 years, respectively.

Moreover, Iranian students with an unhealthy diet and

overweight or obesity had a more risk for higher watch-

TV, using a computer, and ST. The boys were at a
greater risk for excessive use of computers and ST [7].

In another study on both Iranian girls and boys (from 30

provinces of Iran, 13-18 years), the prevalence of ST (TV

and PC) ≥ 2h (43.55 and 39.05%), general obesity (5.43

and 6.7%), abdominal obesity (17.58 and 19.23%), and

overweight (13.9 and 14.1%) were reported, respectively

[8]. The results of a systematic review in 2019 showed

high ST could be one of the risk factors of overweight/

obesity in children and adolescents [9]. The insufficient

leisure-time PA was associated with the grade in both

sexes, weekday ST, excessive use of smartphones during

the weekday and weekend among the boys, studying

tonight, having a work, family income, weekday ST and
dissatisfaction with the own weight among the girls [10].

Polish adolescents (11-13 years) revealed that only 17% of

them had the most active pattern (both low ST and high

PA) with higher adherence in the boys. Physical inactiv-

ity (regardless of ST) was associated with overweight or

central obesity [11].

However, the previous studies have pointed out the

unfavorable impacts of physical inactivity and SB on the

weight status among adolescents around the world, physi-
cal inactivity and SB were affected by socioeconomic

status, gender, race/ethnicity, and geographic character-
istics, and age [4, 9–12]. Therefore, it seems necessary
to conduct the studies with the goal of the investigation
of similar problems in each region. The present study

was aimed to evaluate whether PA and SB related to the

weight status among adolescents.

Methods

Study design and participants

The data of the present cross-sectional study were gath-
ered among the students of Yazd, located in the center of

Iran from April 20, 2019, to June 3, 2019 (before the coro-
navirus disease 2019 (COVID-19) pandemic).

A random multistage cluster sampling method was

performed to select 569 students (12-16 years). The

underweight students (N=59) were excluded from the

present research based on the inclusion and exclusion
criteria. Finally, 510 students were analyzed. The details

for estimating the sample size were previously published

[3, 13]. The eligibility criteria included the students with

normal or overweight and obesity and also complet-

ing written informed consent by both students and their

parents. The thin students (Body mass index (BMI) ≤ -2

Standard deviation (SD)), hospitalized within the last 6

months for any reason, used medicine such as narcotics

and psychotropic, involved with the diseases such as hor-

monal impairment, cardiovascular disorders, malignancy

were excluded from the study.

Measurements

A general questionnaire was used to collect the infor-
mation including gender, age, family size, the education

levels of father or mother, access to the yard, commuting
to school, and grade [7, 14]. The family size was consid-
ered based on the number of children and categorized

into less and more than 2 children. The education level

of the parents was categorized into 3 groups (literacy,

under diploma/diploma, and college) [7]. The students

were asked to determine whether they have access to

the yard. Commuting to school was categorized into a)


active (walking or biking) and b) passive (motor vehicles) [14]. All questionnaires were conducted by the research-trained assistants.

ST, homework time (HT), and SB were assessed for the out of the schools times [7, 8]. SB was assessed by two questions about the duration of time they spend sitting when not at the school 1) how much do you spend on HT (online/ traditional education time, reading, and studying lessons)? and 2) how much time do you spend sitting to use ST tools (TV, computers, tablets, and smartphones)?

The purpose of ST tools use was categorized into 3 groups: 1) only education, 2) leisure/ entertainment, and 3) Both of them. Leisure or entertainment was explained to the students as follows: reading or listening for a fun time, talking with friends, and recreational ST (watching TV, video, time spent in front of a computer screen, smartphone, tablet for any reason). SB was calculated by summing up ST and HT per day [5].

According to the age of the students, the PA questionnaire for the adolescents (PAQ-A) or older children (PAQ-C) was used to assess the general levels of PA for the students [15]. The score ranges for PAQ were from 1- 5. The inactive, moderate, and active students scored between 1- 1.9, 2-3.9, and 4-5, respectively [16].

Anthropometric information (weight, height, BMI, and waist circumference (WC)) were measured in the morning before completing the questionnaires and the students were lightly dressed and without shoes. BMI (kg/m²) was calculated by this equation: weight (kg) /height² (m²). BMI z-score was categorized into normal students (BMI between 1SD to -2SD) and overweight or obesity (BMI ≥1SD)) [17]. Age-and-sex-specific 90th percentile cut-offs of WC was used to categorize into 2 groups including normal (< 90th percentile) and central/abdominal obesity (≥ 90th percentile) [18].

Daily energy intake was assessed by the average of three, 24-h dietary recalls (2 weekdays and 1 weekend) for each student, individually.

Data analysis
The analysis of quantifiable or categorical variables was conducted by means and standard deviations (SD) or frequency (number (%)). The Kolmogorov-Smirnoff test was used to test the normality distribution of data to determine the parametric or non-parametric test. The comparison of the variables was used by t-test in both genders. Binary logistic regression with ‘Enter’ method was used to model the influence of some covariates (predictors) obtained from the questionnaire on the dependent binary variable (overweight or obesity status). Adjusting was considered for the potential confounders including age, sex, grade, family size, and access to the yard based on the previous studies [7, 8, 10, 12]. SPSS statistical software package, version 26.0 (SPSS, Inc, Chicago, Illinois, USA), was applied for the statistical analyses. P < 0.05 was considered as statistically significant using 2-tailed tests.

Results
The participants (50.6 % male and 49.4% female) were randomly selected from six high schools of Yazd. The general characteristics of the students were reported in Table 1. Unfortunately, there was a high prevalence of SB > 2h/day (97.6%), ST > 2h/day (70.3%), overweight or obesity (40%), abdominal obesity (36.9%), and physical inactivity (29.8%) among the students. The size of 44.5% of the families was reported more than four. More than half of the students (53.9%) did not have access to the yard. The main purpose of 73.8% of students who use the ST tools was leisure or entertainment. Commuting to school was passive in 54.7% of the students. It is notable that the main and significant results were shown in the text, the rest of the results were depicted in tables.

Overweight or obese boys reported the higher times for the school days’ ST (p < 0.001), HT (p < 0.001), and SB (p < 0.001) compared to the normal-weight boys. Only ST was shown a significant increase among the overweight or obese boys on the weekends (p = 0.034). Moreover, overweight or obese boys reported a high on all week’s ST (p < 0.001), HT (p = 0.003), and SB (p < 0.001). The PA levels were higher in normal-weight boys compared to the overweight or obese boys (p < 0.001) (Table 2).

Among overweight and obese girls, the school days’ ST (p= 0.001), HT (p = 0.044), and SB (p < 0.001) were higher than normal-weight girls, significantly. The weekends’ ST and SB (p < 0.001) were shown a significant increase in the overweight and obese girls. Higher times on all week’s ST and SB and lower PA levels were found in the overweight or obese girls compared to the normal-weight girls (p < 0.001) (Table 2).

In comparison to the normal-weight students, all overweight or obese students spent more time on the school days and all week ST (p < 0.001), HT (p < 0.001 and 0.005), and SB (p < 0.001), respectively and the weekends’ ST (p < 0.001). The PA levels were more in the normal-weight students than overweight or obese students (p < 0.001) (Table 2).

It is worth that the association of the independent variables with abdominal obesity in the logistic regression model was performed and their results were similar to overweight or obesity. Therefore, the relevant data on abdominal obesity was not shown in the present paper. The results of crude analyses were shown only in Tables 3, 4, and 5.

In the adjusted analyses (age, sex, grade, family size, and access to the yard effects), the association between
the independent variables and overweight or obesity was re-evaluated. In the adjusted analyses, there were higher chances of overweight or obesity for all students at a younger age ($p = 0.014$), more daily energy intake ($p < 0.001$), no access to the yard ($p < 0.001$), passive transportation ($p = 0.001$), the quartile 4 of the school days’ HT ($p = 0.033$), the quartile 2 ($p = 0.044$) and 4 ($p = 0.021$) of the school days’ SB, and the quartile 3 ($p = 0.032$) and 4 ($p = 0.044$) of the weekends’ HT. Moreover, low risk of overweight or obesity was presented among the students with the moderate ($p = 0.001$) and high ($p < 0.001$) levels of PA and lower school days’ ST ($p = 0.022$) (Table 3).

In adjusted analyses, a greater risk of overweight or obesity was related to younger age ($p = 0.018$), more daily energy intake ($p < 0.001$), the family size less than 2 ($p = 0.021$), no access to the yard ($p = 0.023$), and the quartile 2 of SB times on the school days ($p = 0.011$). The moderate ($p = 0.001$) and high ($p < 0.001$) levels of PA were associated with the lower risk of overweight and obesity among the boys (Table 4).

In adjusted analyses, a greater risk of overweight or obesity was related to more daily energy intake ($p < 0.001$), no access to the yard ($p = 0.034$), the quartile 4 of the school days’ HT ($p = 0.046$), the quartile 3 ($p = 0.01$) and 4 ($p = 0.024$) of the weekends’ HT, the quartile 2 of all week ST ($p = 0.032$). The highest levels of PA were associated with a low risk of overweight and obesity in the girls ($p = 0.009$) (Table 5).

### Discussion
The present study evaluated the association of SB, PA, and weight status among the Yazd students aged 12-16 years before the COVID-19. The current findings showed

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**Table 1** Basic characteristics of the study adolescents

| Variables                      | Frequency (%) |
|-------------------------------|---------------|
| Sex (N=510)                   |               |
| Boy                           | 258 (50.6)    |
| Girl                          | 252 (49.4)    |
| Grade (N=510)                 |               |
| Seventh                       | 126 (24.7)    |
| Eighth                        | 168 (32.9)    |
| Ninth                         | 216 (42.6)    |
| Body Mass Index (BMI) (N=510) |               |
| Normal                        | 306 (60)      |
| Overweight or obesity         | 204 (40)      |
| Waist Circumstance (N=510)    |               |
| Normal                        | 322 (63.1)    |
| Abdominal obesity             | 188 (36.9)    |
| Family size (N=510)           |               |
| ≤ 2                           | 283 (55.5)    |
| > 2                           | 227 (44.5)    |
| Education levels of mother (N=498) |          |
| Literacy                      | 4 (0.8)       |
| Under diploma/Diploma         | 207 (40.6)    |
| College                       | 287 (56.3)    |
| Education levels of father (N=504) |            |
| Literacy                      | 6 (1.2)       |
| Under diploma/Diploma         | 156 (30.6)    |
| College                       | 342 (67.1)    |
| Access to the Yard (N= 488)   |               |
| Yes                           | 240 (47.1)    |
| No                            | 248 (52.9)    |
| Commuting to the school (N=510) |            |
| Active transportation (walking or biking) | 231 (45.3) |
| Passive transportation (Motor vehicles) | 279 (54.7) |
| Using screen time (N=504)     |               |
| Yes                           | 499 (99)      |
| No                            | 5 (1)         |
| The purpose of screen time use (N=503) |          |
| Education                     | 21 (4.2)      |
| Leisure/ Entertainment         | 371 (73.8)    |
| Both of them                  | 111 (22)      |
| Physical activity             |               |
| Low                           | 152 (29.8)    |
| Moderate                      | 183 (35.9)    |
| High                          | 175 (34.3)    |

Data presented by frequency (number (%))
Table 2  The comparison of the sedentary and physical activities between the normal weight and overweight or obesity students by gender

| Variables                          | Boy                           | Girl                           | Total                          | P-value |
|-----------------------------------|-------------------------------|--------------------------------|--------------------------------|---------|
| Normal weight                     | Overweight or obesity         | Normal weight                  | Overweight or obesity          |         |
| Sedentary behaviors on school days |                               |                                |                                |         |
| Screen time                       | 119.6 ± 60.3                  | 146.32 ± 64.4                  | 123.70 ± 56.4                  | 0.001   |
| Homework time                     | 134.5 ± 43.2                  | 167.26 ± 71.23                 | 139.48 ± 47.84                 | < 0.001 |
| Sedentary behaviors time          | 254.21 ± 73.56                | 313.58 ± 73.03                 | 263.18 ± 72.81                 | < 0.001 |
| Sedentary behaviors on weekends   |                               |                                |                                |         |
| Screen time                       | 171.91 ± 75.57                | 193.87 ± 89.59                 | 169.48 ± 71.17                 | 0.034   |
| Homework time                     | 185.07 ± 77.7                 | 174.62 ± 81.32                 | 182.37 ± 73.49                 | 0.298   |
| Sedentary behaviors time          | 356.97 ± 103.49               | 368.49 ± 114.05                | 351.85 ± 98.99                 | < 0.001 |
| Sedentary behaviors on all week   |                               |                                |                                |         |
| Screen time                       | 134.55 ± 54.13                | 159.91 ± 57.85                 | 136.78 ± 48.10                 | < 0.001 |
| Homework time                     | 149.02 ± 39.21                | 169.37 ± 60.27                 | 151.73 ± 43.86                 | 0.003   |
| Sedentary behaviors time          | 283.57 ± 67.12                | 329.27 ± 60.8                  | 288.51 ± 63.87                 | < 0.001 |
| Physical Activity                 | 3.58 ± 1.32                   | 1.81 ± 0.96                    | 3.16 ± 1.44                    | < 0.001 |

Data was presented by mean ± standard deviations (SD). Statistical analysis was performed using t-test. P-value < 0.05 was considered significant.

the high prevalence of SB, ST, overweight or obesity, abdominal obesity, and physical inactivity among the Yazd students. Moreover, the higher chance of overweight or obesity among Yazd students was related to the younger age, high energy intake, smaller family size, no access to the yard, passive transportation, higher school days’ HT and SB, and the weekends’ HT, and lack of moderate and high PA levels. A lower school days’ ST was inversely related to overweight or obesity. The higher chances of overweight or obesity were related to the younger age, high energy intake, smaller family size, no access to the yard, the quintile 2 of the school days’ SB, and lack of moderate and high PA levels among boys.

In the girl students, there was a higher risk of overweight or obesity for high energy intake, no access to the yard, spending more time on both the weekends’ and school days’ HT, the quintile 2 of the week’s ST and lack of the high PA levels.

The present findings showed a higher prevalence of overweight and obesity [14] and abdominal obesity [8] rather than the results of the previous studies among Yazd and Iranian students. In line with the present results, some previous studies illustrated that higher PA reverses the trend of overweight [11] or obesity [19].

However, physical inactivity ≥ 2 times was reported in the girl than boy Iranian students aged 13-18 y, the analysis of total students were near the results of the present study [8]. In agreement with our results, however, some previous researches showed a relation positive was found between BMI with physically inactive, using PC ≥ 2 h/day watching TV and Video/DVD, Homework ≥ 2 h/day, and/or high-calorie foods among adolescents of different countries [5, 8, 9, 12], there was not any data for the school days or weekends. The opposite of the current study, a positive association was presented between watching TV or using a PC ≥ 2 hours/day and PA among Iranian children and adolescents [8].

Among Irish students aged 8-11 y, a higher risk of overweight or obesity was linked to physical inactivity and SB on all week, weekdays, and weekends [20]. Our results showed a higher chance of overweight or obesity among the students is relevant to more time on the school days’ SB, HT, and ST and weekends’ HT.

Mozafarian et al. [7] illustrated that there was a negative association between the children number and spending time for SB. The study conducted by Gholami et al. [14] and the present study presented that the Yazd students who used motor vehicles had a higher BMI.
Table 3  Association of independent variables with overweight or obesity in the logistic regression model

| Variables                                | Crude OR (95%CI) | P-value | Adjusted OR (95% CI)* | P-value |
|------------------------------------------|-----------------|---------|----------------------|---------|
| Age (year)                               | 0.98 (0.77, 1.237) | 0.809   | 0.59 (0.39, 0.9)     | 0.014   |
| Sex (male)                               | Female 0.93 (0.647, 1.307) | 0.611   | 1.52 (0.76, 3.02)    | 0.234   |
| Daily energy intake                      | 1.003 (1.002, 1.003) | < 0.001 | 1.003 (1.002, 1.004) | < 0.001 |
| Family Size (≤ 2)                        | 2 < 0.32 (0.21 , 0.49) | < 0.001 | 0.48 (0.26, 0.9)     | 0.023   |
| Access to the Yard (No)                  | Yes 0.21 (0.14 , 0.31) | < 0.001 | 0.2 (0.1, 0.38)      | < 0.001 |
| Commuting to school by (passive transportation)▼ | Active transportation▼ 0.241 (0.16, 0.36) | < 0.001 | 0.34 (0.19, 0.64)    | 0.001   |
| Schooldays. Screen time quartile (1)     | 2 0.9 (0.56, 1.42) | 0.642   | 0.21 (0.06, 0.8)     | 0.022   |
|                                           | 3 6.5 (3.54, 11.93) | < 0.001 | 2.23 (0.34, 14.44)   | 0.4     |
|                                           | 4 2.24 (1.31, 3.82) | 0.003   | 0.71 (0.08, 6.77)    | 0.77    |
| Schooldays Homework time quartile (1)    | 3 0.38 (0.24 , 0.60) | < 0.001 | 0.61 (0.23, 1.63)    | 0.323   |
|                                           | 4 5.25 (3.06, 9.00) | < 0.001 | 7.11 (1.17, 41.28)   | 0.033   |
| Schooldays Sedentary behaviors quartile (1) | 2 1.63 (0.87, 3.04) | 0.128   | 3.23 (1.03, 10.11)   | 0.044   |
|                                           | 3 2.03 (1.29, 3.21) | 0.002   | 2.38 (0.6, 9.4)      | 0.215   |
|                                           | 4 7.81 (4.56, 13.37) | < 0.001 | 10.13 (1.42, 72.28)  | 0.021   |
| Weekends. Screen time quartile (1)       | 2 1.18 (0.72, 1.91) | 0.511   | 1.98 (0.75, 5.2)     | 0.17    |
|                                           | 3 1.54 (0.92, 2.58) | 0.101   | 1.48 (0.43, 5.15)    | 0.533   |
|                                           | 4 2.99 (1.76, 5.07) | < 0.001 | 3.28 (0.62, 17.24)   | 0.16    |
| Weekends. Homework time quartile (1)     | 2 0.73 (0.47, 1.15) | 0.182   | 1.52 (0.55, 4.16)    | 0.418   |
|                                           | 3 1.06 (0.65, 1.74) | 0.810   | 3.82 (1.12,13.10)    | 0.032   |
|                                           | 4 0.63 (0.36, 1.09) | 0.096   | 5.55 (1.04,29.47)    | 0.044   |
| Weekends. Sedentary behaviors quartile (1) | 2 0.99 (0.60, 1.64) | 0.981   | 0.69 (0.24, 1.98)    | 0.493   |
|                                           | 3 0.84 (0.50, 1.41) | 0.510   | 0.42 (0.17, 1.76)    | 0.247   |
|                                           | 4 1.2 (0.72, 1.99)  | 0.491   | 0.27 (0.04,1.85)     | 0.184   |
| All week. Screen time quartile (1)       | 2 1.17 (0.69, 1.98) | 0.551   | 1.8 (0.53, 6.04)     | 0.344   |
|                                           | 3 2.26 (1.34, 3.81) | 0.002   | 2.6 (0.43, 15.9)     | 0.3     |
|                                           | 4 3.11 (1.83, 5.29) | < 0.001 | 1.59 (0.14,17.32)    | 0.708   |
| All week. Homework time quartile (1)     | 2 0.8 (0.49, 1.31)  | 0.369   | 1.1 (0.42, 2.89)     | 0.841   |
|                                           | 3 0.57 (0.34, 0.96) | 0.034   | 0.77 (0.21, 2.82)    | 0.689   |
|                                           | 4 1.79 (1.09, 2.94) | 0.021   | 0.44 (0.06, 3.27)    | 0.418   |
| All week. Sedentary behaviors quartile (1) | 2 1.57 (0.92, 2.7) | 0.099   | 1.76 (0.59,5.18)     | 0.308   |
|                                           | 3 2.78 (1.62, 4.77) | < 0.001 | 0.83 (0.16, 4.35)    | 0.824   |
|                                           | 4 5.14 (2.99, 8.83) | < 0.001 | 0.52 (0.05, 4.93)    | 0.567   |
| All week. Physical activity (low)         | Moderate 0.485 (0.311, 0.757) | 0.001 | 0.426 (0.207, 0.874) | 0.020   |
|                                           | High 0.033 (0.016, 0.066) | < 0.001 | 0.039 (0.013, 0.118) | < 0.001 |

OR: Odds ratio, CI: Confidence Interval. P-value < 0.05 was considered significant

* Adjusted for age, sex, grade, family size, access to the yard
▼ Commuting to school by walking or biking was considered as active transportation
▼ Commuting to school by motor vehicles was considered passive transportation
Table 4  Association of independent variables with overweight or obesity in the logistic regression model in boys

| Variables                                      | Crude OR (95%CI) | P-value | Adjusted OR (95% CI)* | P-value |
|------------------------------------------------|------------------|---------|------------------------|---------|
| Age (year)                                     | 0.837 (0.6, 1.167) | 0.294 | 0.401 (0.188, 0.858) | 0.018   |
| Daily energy intake                            | 1.002 (1.001, 1.003) | < 0.001 | 1.003 (1.002,1.004) | < 0.001 |
| Family Size (≤ 2)                              | 2 < 0.462 (0.262, 0.814) | 0.008 | 4.419 (1.254, 15.575) | 0.021   |
| Access to the Yard (No)                        | 0.185 (0.103, 0.332) | < 0.001 | 0.248 (0.075, 0.822) | 0.023   |
| Commuting to school by (passive transportation)| Active transportation ▼ | 0.244 (0.143, 0.416) | < 0.001 | 1.083 (0.367, 3.195) | 0.885   |
| Schooldays. Screen time quartile (1)           | 2 0.892 (0.468, 1.7) | 0.728 | 0.174 (0.023, 1.303) | 0.089   |
|                                                  | 3 5.793 (2.483,13.517) | < 0.001 | 3.430 (0.181, 64.908) | 0.411   |
|                                                  | 4 2.069 (1.008,4.245) | 0.047 | 0.507 (0.015, 17.063) | 0.705   |
| Schooldays. Homework time quartile (1)         | 3 0.378 (0.197,0.727) | 0.004 | 0.2 (0.035, 1.144) | 0.070   |
|                                                  | 4 7.389 (3.302,6.535) | < 0.001 | 1.5 (1.014, 21.562) | 0.765   |
| Schooldays. Sedentary behaviors quartile (1)   | 2 1.867 (0.808,4.31) | 0.144 | 11.303 (1.738,73.504) | 0.011   |
|                                                  | 3 2.333 (1.205,4.519) | 0.012 | 1.76 (0.189, 16.432) | 0.620   |
|                                                  | 4 10.37 (4.767,22.561) | < 0.001 | 2.701 (0.091, 79.897) | 0.565   |
| Weekends. Screen time quartile (1)             | 2 1.192 (0.62, 2.294) | 0.598 | 2.729 (0.491, 15.168) | 0.251   |
|                                                  | 3 1.382 (0.668,2.86) | 0.383 | 0.799 (0.103, 6.218) | 0.830   |
|                                                  | 4 2.12 (1.025,4.386) | 0.043 | 2.316 (0.136, 39.448) | 0.562   |
| Weekends. Homework time quartile (1)           | 2 0.707 (0.369,1.354) | 0.295 | 0.93 (0.187, 4.616) | 0.929   |
|                                                  | 3 1.161 (0.582,2.316) | 0.672 | 1.559 (0.232,10.502) | 0.648   |
|                                                  | 4 0.682 (0.331,1.404) | 0.299 | 1.215 (0.096,15.325) | 0.881   |
| Weekends. Sedentary behaviors quartile (1)     | 2 0.963 (0.467,1.984) | 0.919 | 0.481 (0.097, 2.396) | 0.372   |
|                                                  | 3 0.869 (0.440,1.718) | 0.687 | 0.209 (0.02, 2.232) | 0.195   |
|                                                  | 4 0.626 (0.301,1.301) | 0.21 | 0.153 (0.008, 2.981) | 0.215   |
| All week. Screen time quartile (1)             | 2 0.955 (0.463,1.969) | 0.9 | 0.826 (0.121, 5.623) | 0.845   |
|                                                  | 3 2.026 (0.997,4.114) | 0.051 | 1.944 (0.094, 40.201) | 0.667   |
|                                                  | 4 2.39 (1.166,4.899) | 0.017 | 1.63 (0.028, 94.137) | 0.813   |
| All week. Homework time quartile (1)           | 2 0.858 (0.424,1.738) | 0.671 | 2.887 (0.518, 16.075) | 0.226   |
|                                                  | 3 0.473 (0.224,1) | 0.05 | 1.736 (0.214,32.32) | 0.608   |
|                                                  | 4 2.471 (1.238,4.933) | 0.01 | 8.549 (0.304,240.721) | 0.208   |
| All week. Sedentary behaviors quartile (1)     | 2 1.884 (0.889,3.993) | 0.098 | 1.057 (0.199,5.625) | 0.948   |
|                                                  | 3 2.476 (1.148,5.339) | 0.021 | 0.392 (0.025, 6.11) | 0.504   |
|                                                  | 4 6.19 (2.827,13.556) | < 0.001 | 1.536 (0.03, 78.886) | 0.831   |
| All week. Physical activity (low)               | Moderate 0.359 (0.179,0.723) | 0.004 | 0.132 (0.04, 0.437) | 0.001   |
|                                                  | High 0.022 (0.008,0.061) | < 0.001 | 0.004 (0.001, 0.034) | < 0.001 |

OR Odds ratio, CI Confidence Interval. P-value < 0.05 was considered significant
* Adjusted for age, sex, grade, family size, access to the yard
▼ Commuting to school by walking or biking was considered as active transportation
▼ Commuting to school by motor vehicles was considered passive transportation
| Variables | Crude OR (95%CI) | P-value | Adjusted OR (95% CI)* | P-value |
|-----------|------------------|---------|-----------------------|---------|
| Age (year) | 1.115 (0.76, 1.635) | 0.578 | 1.081 (0.411, 2.844) | 0.874 |
| Daily energy intake | 1.006 (1.005, 1.008) | <0.001 | 1.007 (1.004, 1.009) | <0.001 |
| Family Size (≤ 2) | 2 | 0.221 (0.12, 0.407) | <0.001 | 0.703 (0.175, 2.82) | 0.619 |
| Access to the Yard (No) | Yes | 0.206 (0.119, 0.355) | <0.001 | 0.227 (0.058, 0.893) | 0.034 |
| Commuting to school by (passive transportation) | Active transportation | 0.225 (0.123, 0.41) | <0.001 | 0.594 (0.142, 2.482) | 0.475 |
| Schooldays. Screen time quartile (1) | 2 | 0.929 (0.474, 1.819) | 0.829 | 0.190 (0.016, 1.918) | 0.184 |
| 3 | 7.429 (3.091, 18.555) | <0.001 | 1.158 (0.024, 54.901) | 0.941 |
| 4 | 2.476 (1.112, 5.514) | 0.026 | 0.578 (0.004, 85.199) | 0.830 |
| Schooldays. Homework time quartile (1) | 3 | 0.385 (0.2, 0.74) | 0.004 | 0.5 (0.067, 3.735) | 0.5 |
| 4 | 3.791 (1.815, 7.917) | <0.001 | 736.588 (1.118, 485356.584) | 0.046 |
| Schooldays. Overall Sedentary behaviors times quartile (1) | 2 | 1.375 (0.53, 3.564) | 0.512 | 2.152 (0.155, 29.866) | 0.568 |
| 3 | 1.793 (0.954, 3.372) | 0.070 | 5.178 (0.371, 72.241) | 0.221 |
| 4 | 5.867 (2.77, 12.426) | <0.001 | 5.183 (0.113, 238.025) | 0.399 |
| Weekends. Screen time quartile (1) | 2 | 1.163 (0.564, 2.397) | 0.682 | 2.215 (0.317, 15.459) | 0.422 |
| 3 | 1.768 (0.842, 0.713) | 0.132 | 4.851 (0.33, 71.214) | 0.249 |
| 4 | 4.343 (1.998, 9.441) | <0.001 | 53.256 (1.773, 1599.286) | 0.022 |
| Weekends. homework time quartile (1) | 2 | 0.764 (0.405, 1.439) | 0.404 | 5.176 (0.403, 66.498) | 0.207 |
| 3 | 0.974 (0.479,1.978) | 0.941 | 53.685 (2.619, 1100.448) | 0.010 |
| 4 | 0.555 (0.239, 1.288) | 0.171 | 110.577 (1.843, 6633.313) | 0.024 |
| Weekends. Overall sedentary behaviors times quartile (1) | 2 | 0.725 (0.353, 1.489) | 0.381 | 0.326 (0.034, 3.119) | 0.331 |
| 3 | 0.778 (0.380, 1.592) | 0.492 | 0.072 (0.002, 2.076) | 0.125 |
| 4 | 0.784 (0.389, 1.58) | 0.496 | 0.03 (0.000, 3.099) | 0.139 |
| All week. Screen time quartile (1) | 2 | 1.513 (0.699, 3.272) | 0.293 | 15.83 (1.259, 198.978) | 0.032 |
| 3 | 2.647 (1.212,5.78) | 0.015 | 36.837 (0.967, 1403.868) | 0.052 |
| 4 | 4.286 (1.926, 9.537) | <0.001 | 22.237 (0.097, 5090.267) | 0.263 |
| All week. Homework time quartile (1) | 2 | 0.743 (0.371, 1.486) | 0.401 | 0.286 (0.031, 2.650) | 0.271 |
| 3 | 0.679 (0.33, 1.399) | 0.294 | 0.430 (0.024, 7.824) | 0.568 |
| 4 | 1.249 (0.609, 2.561) | 0.544 | 0.009 (0.000, 4.794) | 0.141 |
| All week. Overall sedentary behaviors times quartile (1) | 2 | 1.272 (0.582, 2.779) | 0.547 | 0.602 (0.06, 6.053) | 0.667 |
| 3 | 3.138 (1.462, 6.736) | 0.003 | 1.146 (0.004, 5.151) | 0.290 |
| 4 | 4.333 (2.046, 0.176) | <0.001 | 0.025 (0.000, 2.061) | 0.101 |
| All week. Physical activity (low) | Moderate | 0.538 (0.292,0.989) | 0.046 | 1.25 (0.276, 5.66) | 0.772 |
| High | 0.041 (0.015, 0.112) | <0.001 | 0.069 (0.009, 0.518) | 0.009 |

OR Odds ratio, CI Confidence Interval. P-value < 0.05 was considered significant

1 Adjusted for age, sex, grade, family size, access to the yard
2 Commuting to school by walking or biking was considered as active transportation
3 Commuting to school by motor vehicles was considered passive transportation
A more high prevalence (64.5%) of active transportation was reported by Gholami et al. [14]. It may emanate from that the choice of high quality and facilities school has higher importance rather than near distance for the parents [14]. Attention to active transport is so important due to its role in expending a large amount of energy [14].

As the previous studies and the present study emphasized, the risk factors of overweight or obesity, were varied based on age, race, country, SES, parents’ education levels, cultural reasons and gender [11, 21]. For example, some families or countries may not encourage girls to take part in physical activities due to cultural reasons [21] or unhealthier dietary habits in boys [22] or girls [21].

The limitations of our study were a) using self-reported data on dietary intake, ST, SB and PA (however, the present questionnaire was used in previous studies [7, 8, 11, 15, 23]), b) the content of dietary intake were not assessed for the current study, the interpretation should be done with caution given that this is a cross-sectional study, c) the consideration of more confounder factors including the quality and quantity of dietary intake, sleep habits, socioeconomic status (SES), parent history of overweight or obesity, and etc., d) the lack of the data for all year (the data was collected at a particular point of time (only for an academic year), the adolescents’ distance from school was not considered, and finally SB was assessed for the activities out of the school time.

Our study had some strong aspects including 1) sample size was nearly large; 2) data were collected from both gender; 3) the analysis was performed based on both genders as well as the weekdays and weekends apart from all week; 4) the evaluation of the relationship between overweight or obesity with daily energy intake, PA and the times spent on ST, HT, and SB; 5) the analysis for abdominal obesity was performed (due to the similarity to the present results did not show); 6) the presence of the qualified and same assessors while filling in the questionnaire allowed adolescents to clarify uncertainties and reduce the biases; and finally, the data for ST and SB was comprehensive.

According to the current and previous findings [3–7, 11, 13, 15], it seems to be necessary that policymakers should take the measures to modify lifestyles to reduce the prevalence of overweight or obesity during adolescence.

However, the socioeconomic issues affected on social isolation, negatively or positively, a reduction in several health-related behaviors (insufficient PA, increased sleep time, reduced fruit and vegetable consumption, too much ST) was shown during COVID-19 lockdown [24, 25].

We suggest performing a large and comprehensive study to collecting the data for the evaluation and comparison of PA and SB between the academic year and summer holidays as well as during and before the COVID-19 lockdown. Given that the changes in lifestyle during the COVID-19 confinement (mandatory online education, the closure of the school, higher sleep time, and the more accessible cyberspace) may worsen health-related behaviors [24, 25]. In addition, it seems to be necessary to conduct more researches on more risk factors of obesity in the different regions of the world given that the risk factors of overweight or obesity were too wide [11].

Conclusion
The prevalence of SB, ST, overweight or obesity, abdominal obesity, and physical inactivity was common among Yazd students. Among the students, the daily energy intake, PA, younger age and family size, passive transportation, access to the yard, school days’ HT and SB and the weekends’ HT were related to overweight or obesity. As the results were presented, the chances of overweight or obesity were dissimilar in boys and girls. Given that the high prevalence of unhealthy lifestyles among adolescents during regular life situations, it will be a major alarm for the decision-makers on the adolescents’ health especially during and after the COVID-19 pandemic.

Acknowledgements
We thank the cooperation of Yazd province’s Education and Training administration, high schools and their students to participate in this project. Moreover, we thank the assistance researchers (Shamim Shams-Rad, Mahtab Tabatabaee, Farhang Mirzavandi, and Siavash Babaie).

Authors’ contributions
Hassan Mozaffari-Khosravi, Majid Karandish and Maryam Azhdari designed the research; Maryam Azhdari were responsible for the data collection; Maryam Azhdari and Ali Mohammad Hadianfard analyzed the data; Maryam Azhdari and Ali Mohammad Hadianfard were involved in drafting the paper. All of the authors read and approved the final paper.

Funding
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations
Ethics approval and consent to participate
The study protocol was approved by the Research Ethical Committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1396.1087). The coordination and agreement were made with the Education Department of Yazd. The written informed consent was obtained from the students and their parents to participate in this study after receiving a complete explanation of the study protocols and objectives.

Consent for publication
The authors affirm that human research participants provided informed consent for publication of their data.

Competing interests
The authors declare that there are no competing interests.
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Received: 29 June 2021 Accepted: 13 September 2021 Published online: 23 September 2021

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