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ORIGINAL RESEARCH

Sedentary behavior is associated with musculoskeletal pain in adolescents: A cross sectional study

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Abstract
Background: High prevalence of back pain has been observed in adolescents. Sedentary behavior (SB) is considered a risk factor for musculoskeletal pain. The association between back pain and SB in the pediatric/adolescent population is not well established.
Objective: To investigate the association between SB and low back and neck pain in adolescents according to sex.
Methods: This is a cross-sectional study with children and adolescents aged 10-17 years, randomly recruited from public and private schools in Presidente Prudente, Brazil. All students enrolled in the selected schools were eligible to participate. SB was evaluated by adding the number of hours of use of screen devices, such as television, computer, video game, and smartphone/tablet. To assess neck and low back pain, the Nordic Musculoskeletal Questionnaire was used. Physical activity and socioeconomic status were assessed by the Baecke Questionnaire and the Brazilian Criteria for Economic Classification (ABEP), respectively. Odds ratio (OR) from Binary Logistic Regression in the unadjusted and adjusted model (physical activity, abdominal obesity, and socioeconomic status) showed the relationship between musculoskeletal pain and SB.
Results: A total of 1011 adolescents (557 girls) with a mean $\pm$ standard deviation age of 13.2$\pm$ 2.4 years were included. Moderate (OR = 1.80; 95%CI: 1.00, 3.23) and high (OR = 1.91; 95%CI: 1.02, 3.53) SB were associated with neck pain in girls. In boys, moderate SB (OR = 2.75; 95%CI:

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1.31, 5.78) were associated with neck pain. Moderate (OR = 2.73; 95%CI: 1.45, 5.02) and high (OR = 2.49; 95%CI: 1.30, 4.76) SB were associated with low back pain only in girls.
Conclusion: Moderate and high SB were associated with neck pain in girls and boys, while moderate and high SB were associated with low back pain only in girls.

Introduction

Low back and neck pain are the most common musculoskeletal disorders affecting the spine among adults.[1] In adolescents, these conditions have increased significantly in the last decade.[2] There is evidence that adolescents with musculoskeletal pain are more likely to develop chronic musculoskeletal pain in adulthood.[3,4] Understanding the factors associated with musculoskeletal pain in early ages may help develop effective strategies for prevention and treatment of chronic musculoskeletal pain later in life.

There are several well-stablished risk factors for low back and neck pain, including lifestyle behaviors, such as physical activity and sedentary behavior (SB).[5-7] While studies investigating the association between physical activity and musculoskeletal pain have been increasing,[8,9] few of them have focused on SB[10] (defined as activities in which the energy expenditure is below 1.5 METS in a sitting, lying, or reclining position).[11] The most common SB, especially among adolescents, is the time spent watching television, using the computer, playing video games, and using a smartphone.[12] In this population, time spent sitting at school was associated with low back pain.[13] Similarly, increased computer use is associated with neck pain in Finnish adolescents.[14] On the other hand, Yao et al.[15] found no association between time spent watching TV and using computer with low back pain.

Although few studies have investigated the association between SB and musculoskeletal pain, there are limitations that need to be addressed. For instance, a previous study on the topic has considered only sex and age as potential confounders.[14] There are characteristics, such as abdominal obesity and physical activity, that should also be included in multivariable models, as they are also related to low back pain.[16,17] In addition, there is no study investigating possible differences in this association according to sex. Finally, to our knowledge, there is no study investigating this association in midle-income countries. Therefore, the aim of this study was to investigate the association between SB and low back and neck pain in adolescents from Brazil according to sex.

Methods

Study design and setting

This is a cross-sectional study involving a school-based sample of children and adolescents. Participants were randomly recruited from public and private schools in the city of Presidente Prudente, Brazil. Recruitment and data collection took place between the years 2014-2015. To participate in the study, adolescents were authorized by their parents or guardians through an informed consent form. The study was approved by the Ethics and Research Committee of Universidade Estadual de São Paulo (UNESP), Presidente Prudente, SP Brazil.

Participants

The sample of this study consisted of students aged 10-17 years from public and private schools in the city of Presidente Prudente, Brazil. For random selection purpose, five public (one from each region of the city: north, south, east, west, and central area) and two private (because there are no private schools in all regions of the city) schools were selected, taking into account the proportionality between public and private institutions in the city. The researchers explained the objectives of the study to the students and those who expressed interest needed the signature of their parents and/or guardians authorizing them to participate in the study.

Data collection

Sedentary behavior

SB was assessed as the time spent with screen devices (e.g., watching TV, playing videogames, using computer and smartphones, including e-communications, e-games, and internet) as proposed by Hardy et al.[18] Participants were asked about how many hours they spent in screen devices in a typical weekday and in a typical weekend day. The sum of time spent with each device comprised the total SB per day. A weighted average hours per week in SB was calculated. The weekly time (hours) in SB were further divided into quartiles, and participants were classified in low (first quartile [Q1]: $\leq$3.25 hours/day), moderate (intermediate quartiles [Q2 and Q3]: 3.26 to 7.59 hours/day), or high SB (upper quartile [Q4]: $\geq$7.60 hours/day). This questionnaire was validated for Brazilian adolescents[19] and has good to excellent reliability for measuring SB in this population (intraclass correlation coefficient $\geq$0.70).[18]

Low back and neck pain

Back and neck pain was assessed by the validated standardized Brazilian version[20] of the Nordic Questionnaire.[21] This instrument was validated for adolescents[22] and has been widely used in Brazilian samples.[23-25] This questionnaire has an illustrative body chart identifying areas with musculoskeletal disorders for nine sites: neck, shoulders, upper back, elbows, low back, wrist/hands, hips/thighs, knees, and ankles/feet. The participants respond about the presence of any musculoskeletal complaints (i.e., pain) in the last 7 days and in the last 12 months. For the purpose of the present study, we limited information about the back and neck region and the reporting of pain to the last week, to match the time-frame recall of the SB Questionnaire. Those adolescents who reported musculoskeletal pain in the neck

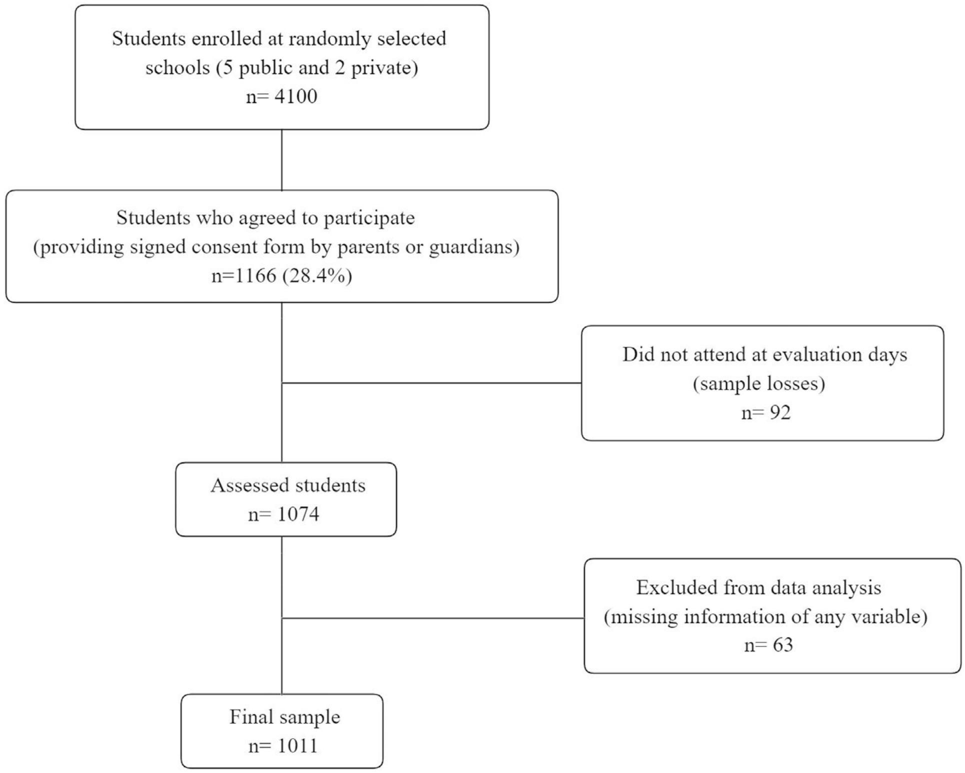

Fig. 1 Flowchart of sampling process.

or low back regions in this instrument were respectively classified as having neck and low back pain.

Anthropometry

Anthropometric measurements were performed with participants barefoot and wearing their school uniform, without coats or personal belongings, according to international standards.[26] Height was measured using a portable stadiometer with maximum height of 2.2 meters and 0.1cm precision.[26] Body weight was assessed with a portable digital scale (Plenna, São Paulo, Brazil) with maximum capacity of 150 kilograms (kg) and 0.1kg precision, with participant standing in the center of the scale, with hands at sides and looking straight ahead.[26] Body mass index was calculated by weight in kilograms divided by height in meters squared. Waist circumference was measured in centimeters with an inextensible tape with maximum at the midpoint between the lowest rib and the iliac crest.[27] All measurements were performed by trained professionals (i.e., physical education background and physical therapists).

Physical activity

Physical activity was assessed using the Baecke questionnaire.[28] This instrument considers activities in the last 12 months and consists of 16 questions in three different domains: school activities (questions 1 to 8); sport practice (questions 9 to 12); and leisure-time activities (questions 13 to 16). Answers were coded using a 5-point Likert scale and provided a dimensionless score (higher scores indicate high physical activity levels). The sum of the three domain scores corresponded to the total physical activity level. This instrument was used because it was validated against gold-standard methods such as doubly labeled water[29] and has been validated for Brazilian adolescents.[30]

Socioeconomic classification

Socioeconomic status was assessed by the Brazilian Criteria for Economic Classification, developed by the Brazilian Association of Research Companies (ABEP).[31] This instrument considers level of education, house characteristics, and consumer goods, and classifies participants from highest to lowest economic classes: A1, B1, B2, C1, C2, and D-E.[31]

Sample size

Sample size calculation was performed considering a 70% prevalence of SB,[32] a 4% error, and design correction of 1.5 (selection bias). Furthermore, a 10% increase in sample size was added to account for possible sample losses. The final desired sample size was a minimum of 821 participants.

Statistical analysis

Data were presented in means and standard deviation (SD). The association between SB and neck and low back pain was tested by binary logistic regression models, generating values of odds ratio (OR) and 95% confidence intervals (95% CI), adjusted for potential covariates (i.e., socioeconomic level, physical activity, and waist circumference). This group of variables was selected based on a theoretical approach, given the evidence supporting the association between these variables and back and neck pain.[24,33-34] The statistical significance used was 5%. The statistical package used was SPSS version 24.0.

Results

Seven schools were randomly selected (5 public and 2 private schools) and 4100 participants were invited. Of these, 1166 (28.4%) agreed to participate and provided signed consent form (from parents or guardians), and 1074 were evaluated. Sixty-three participants were excluded due to missing data, and a total of 1011 adolescents (557 girls), mean age of 13.1 ± 2.3 years old were included in the analysis (Fig. 1).

High SB was observed in 21.6% (*n* = 218) of participants. The prevalence of low back and neck pain was 18.0% (*n* = 182) and 17.4% (*n* = 176), respectively. Boys and girls participants with high SB were older, heavier, and taller than participants with low SB. In addition, boys with high SB had higher waist circumference than their peers with low SB (Table 1).

Boys with moderate SB were 2.7 (95%CI: 1.31, 5.78) times more likely to have neck pain when compared to those with low SB. Similar findings were observed for girls (Table 2).

There was no significant association between SB and low back pain in boys. However, girls with moderate and high SB were 2.5 times (95%CI: 1.30, 4.76) more likely to have low back pain (Table 3).

When considering the cluster analysis of symptoms of back pain, that is, adolescents who had pain in the neck and lumbar region at the same time, the highest prevalence of pain in both regions (neck and low back) was observed in adolescents with moderate and high SB in boys, but this difference was not significant (p=0.092). However, in girls, the highest prevalence of symptoms was concomitantly observed in girls who were classified as having high SB (p=0.004). This information is presented in Fig. 2.

Discussion

The main findings of this study were that ~80% of adolescents were classified as having moderate or high SB. Moderate to high SB was associated with the presence of neck pain in boys and girls. High SB was associated with low back pain only in girls.

The high prevalence of SB in adolescents has been reported by previous studies,[35-36] which is consistent with our findings. The association between SB and neck pain was observed in both boys and girls. Poor body posture when using handheld mobile devices could be one of the reasons for these findings. Prolonged time with forward flexion of the head may cause an overload of cervical spine, muscles, ligaments, and tendons, which may result in pain in this area, a postural phenomenon previously named Text Neck Syndrome.[37] For instance, Brink et al.[38] found that increased time spent using a computer is associated with upper back pain in adolescents. The mechanisms underlying this association remain unclear. A possible explanation for this association may be that prolonged time in the sitting position would contribute to a greater rigidity of the spine,[39] which could

Table 1 Characteristics of the sample according to sedentary behaviors classification.

Variables	All (*n* = 1011)	Low SB (*n* = 268)	Moderate SB (*n* = 525)	High SB (*n* = 218)	Mean difference-SB (95%CI)		
					Low x Moderate	Low x High	Moderate x High
Boys							
Age (years)	12.9 ± 2.4	11.9 ± 2.3	13.0 ± 2.4[a]	13.6 ± 2.6[a]	−1.03 (−1.68, −0.39)	−1.64 (−2.33, −0.94)	−0.60 (−1.21, 0.15)
Weight (kg)	49.9 ± 15.0	46.4 ± 16.0	49.3 ± 13.7	53.6 ± 15.2[a,b]	−2.90 (−7.07, 1.25)	−7.21 (−11.71, −2.71)	−4.30 (−8.29, −0.32)
Height (cm)	155.5 ± 13.5	151.2 ± 13.9	155.5 ± 13.0[a]	159.0 ± 12.7[a,b]	−4.33 (−8.03, −0.64)	−7.83 (−11.82, 3.83)	−3.49 (−7.03, 0.04)
Physical activity (BS)	9.5 ± 2.7	9.1 ± 2.5	9.5 ± 2.7	9.6 ± 2.9	−0.42 (−1.17, 0.32)	−0.47 (−1.27, 0.34)	−0.04 (−0.76, 0.67)
Waist circumference (cm)	68.9 ± 9.8	67.8 ± 10.0	68.0 ± 8.8	70.9 ± 10.6[a,b]	−0.25 (−2.97, 2.45)	−3.12 (−6.05, −0.20)	−2.87 (−5.46, 0.27)
Girls							
Age (years)	13.4 ± 2.3	12.0 ± 2.4	13.9 ± 2.3[a]	13.9 ± 2.1[a]	−1.96 (−2.50, −1.42)	−1.94 (−2.53, −1.35)	0.02 (−0.50, 0.54)
Weight (kg)	50.5 ± 14.5	45.9 ± 14.8	51.1 ± 14.5[a]	53.5 ± 14.1[a,b]	−5.22 (−8.80, −1.64)	−7.64 (−11.51, −3.76)	−2.42 (−5.86, 1.02)
Height (cm)	155.9 ± 12.1	149.5 ± 12.1	157.3 ± 11.1[a]	159.5 ± 11.3[a]	−7.77 (−10.67, −4.88)	−9.93 (−13.06, −6.80)	−2.16 (−4.94, 0.62)
Physical activity (BS)	8.8 ± 2.8	9.0 ± 2.5	8.7 ± 2.9	8.7 ± 2.9	0.23 (−0.92, 0.46)	0.30 (−0.44, 1.05)	−0.04 (−0.76, 0.67)
Waist circumference (cm)	68.0 ± 9.6	67.4 ± 10.7	67.7 ± 9.5	69.1 ± 8.7	−0.28 (−2.70, 2.13)	−1.65 (−4.28, 0.96)	−1.37 (−3.70, 0.96)

Data are presented as mean ± standard deviation; SB, sedentary behavior; BS, Baecke's score.
[a] Different from Low SB.
[b] Different from Moderate SB.

Table 2 Association between neck pain and sedentary behaviors in adolescents.

Neck Pain		
	Crude model OR (95% CI)	Adjusted model OR (95% CI)
Boys (*n* = 454)		
Low SB	Reference	Reference
Moderate SB	**2.60 (1.25, 5.45)**	**2.75 (1.31, 5.78)**
High SB	2.11 (0.96, 4.65)	2.09 (0.94, 4.65)
Girls (*n* = 557)		
Low SB	Reference	Reference
Moderate SB	1.73 (0.97, 3.07)	**1.80 (1.00, 3.23)**
High SB	**1.95 (1.07, 3.57)**	**1.91 (1.02, 3.53)**

SB, sedentary behaviour; adjusted model: socioeconomic level, physical activity, and waist circumference.

Table 3 Association between low back pain and sedentary behaviors in adolescents.

Low Back Pain		
	Crude model OR (95% CI)	Adjusted model OR (95% CI)
Boys (*n* = 454)		
Low SB	Reference	Reference
Moderate SB	1.70 (0.86, 3.38)	1.86 (0.92, 3.77)
High SB	1.66 (0.80, 3.45)	1.71 (0.80, 3.65)
Girls (*n* = 557)		
Low SB	Reference	Reference
Moderate SB	**2.80 (1.52, 5.15)**	**2.73 (1.45, 5.02)**
High SB	**2.64 (1.39, 5.02)**	**2.49 (1.30, 4.76)**

SB, sedentary behaviour; adjusted model: socioeconomic level, physical activity, and waist circumference.

affect anatomical structures (e.g., intervertebral discs) and lead to episodes of neck pain.

Smartphone use is another very common behavior among adolescents. Smartphones has several functions that involve social networks and different applications. Our results corroborate those of Mustafaoglu et al.[40], who observed an association between smartphone use and neck pain in adolescents. The posture of adolescents with the neck flexed for a long time could be related to pain in the neck region.[41-42] In addition, the protracted position of the shoulders along with the flexion of the elbows, wrists, and hands during typing could also contribute to the increased prevalence of pain in the neck.[43]

Our results showed an association between moderate and high SB with low back pain only in girls. We would argue that sex-specific characteristics may, at least in part, explain this finding. The mean age of girls in our study was 13.4 years and, at this age, girls have hormonal changes, including menarche. Ghilan et al.[44] found that the menstrual cycle was associated with low back pain in female nurses. This association may be related to elevated inflammatory markers, such as high-sensitivity C-reactive protein.[45] Another possible explanation would be related to lifestyle. For instance, SB has been inversely associated with physical activity.[25,46] In addition, girls often have lower physical activity levels than boys.[36] Because physical activity is associated with low back pain,[47-48] these lifestyle behaviors may contribute to the association found in our study.

This study has limitations that should be considered. First, the cross-sectional design does not allow cause-effect assumptions. Given that both the exposure and the outcome were measured at the same time frame, it is not possible to infer a causal relationship. Second, the lack of information on menstrual cycle may be considered an important limitation. Future mechanistic research should investigate the possible pathways involved in the association between menstrual cycle and low back pain. Finally, the self-selection of participants may have underestimated the prevalence of SB and/or musculoskeletal pain in relation to the background population (selection bias). The strengths of this study include the randomly school-based sampling process and appropriate sample size, with design correction to reduce selection bias. Another point to be considered is that confounding variables related to SB and neck and/or low back pain (age, socioeconomic level, and waist circumference)[36,49-52] were considered as an adjustment to avoid possible bias in the results.

Future randomized controlled trials should investigate whether strategies to reduce SB would be effective in

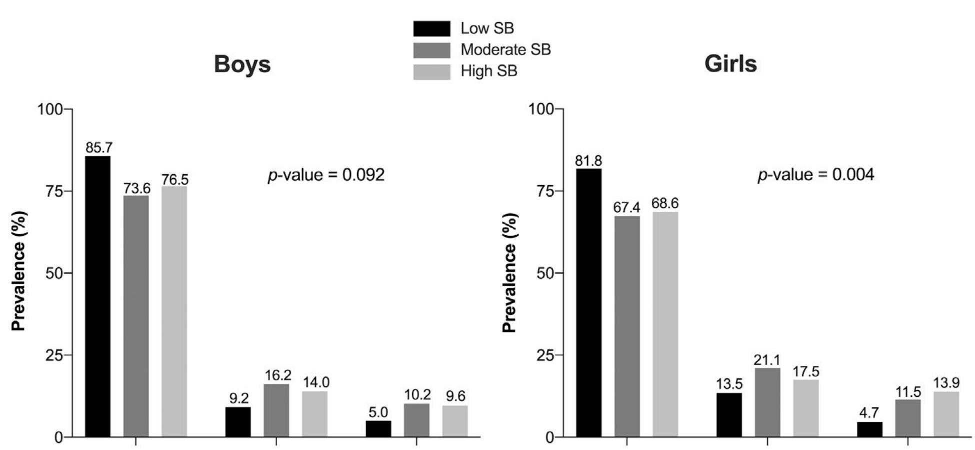

Fig. 2 Prevalence of back pain according to sedentary behavior (SB).

reducing prevalence and incidence of low back and neck pain in children and adolescents.

Conclusion

We found that SB was associated with neck pain in boys and girls, while the association between SB and low back pain was observed only in girls. Future studies should investigate whether reducing time spent in screen-based behaviors would help to prevent musculoskeletal pain in this population.

Conflict of interest

None.

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