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ORIGINAL RESEARCH

Incidence and factors associated with low back pain in adolescents: A prospective study

Alberto de Vitta[a,*], Thiago Paulo Frascareli Bento[b], Guilherme Porfirio Cornelio[c], Priscila Daniele de Oliveira Perrucini[c], Lilian Assunção Felippe[c], Marta Helena Souza de Conti[d]

[a] *Physical Therapy Course, Centro Universitário de Ourinhos, Ourinhos, SP, Brazil*
[b] *Master's Program in Functional Health Physiotherapy Universidade do Sagrado Coração (USC), Bauru, SP, Brazil*
[c] *Physical Therapy Course, Universidade do Sagrado Coração (USC), Bauru, SP, Brazil*
[d] *Universidade Anhanguera-Uniderp, Campo Grande, MS, Brazil*

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Abstract
Background: Low back pain (LBP) is a common complaint among children and adolescents and can negatively impact their physical and mental health. Although previous studies investigating the incidence of low back pain (LBP) in children and adolescents have been performed in high income countries, it is unclear whether countries such as Brazil would show similar incidence rates.
Objective: To determine the incidence and to identify predictors of new episodes of LBP in high school students.
Methods: This is a 1-year longitudinal study of high school students from public schools in the city of Bauru, Sao Paulo. Collected clinical data were: demographic and socioeconomic factors, information on the use of electronic devices, mental health status (the Strengths and Difficulties Questionnaires), level of habitual physical activity (Baecke Physical Activity Questionnaire), and incidence of LBP (measured with question about LBP in the past 12 months and the Nordic Musculoskeletal Questionnaire). Descriptive analysis and bivariate and multivariate logistic regressions were performed.
Results: The cumulative incidence of new LBP episodes for the total cohort of 757 high school students was 18.9% (95% CI: 16.2, 21.8). The cumulative incidence was 14.8% (95% CI: 11.7, 18.5) for male students and 24.1% (95% CI: 19.8, 29.9) for female students. Being a female student (OR = 1.78; 95% CI: 1.23, 2.59), sitting posture while using tablet (OR = 4.34; 95% CI: 1.19, 16.60), daily time spent on tablet (OR = 3.21; 95% CI: 1.41, 7.30), daily time spent on mobile phone (OR =1.49; 95% CI: 1.11, 2.00), lying posture while using mobile phone (OR = 1.49; 95% CI: 1.05, 2.12), and mental health status (OR = 2.81; 95% CI: 1.76, 4.48) were identified as predictor variables.

* Corresponding author. Alberto De Vitta, Rua Américo Persin, 158, CEP 17495-334, Piratininga, SP. Tel: 55 14 997176398.
E-mail: albvitta@gmail.com (A.d. Vitta).

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Conclusion: Our findings showed that one in five high school students reported having a LBP episode over the last year. The predictors found to be associated with low back pain include those related to sex, time and posture while using electronic devices, and mental health status.

Introduction

Musculoskeletal pain, especially low back pain (LBP), is a common complaint among children and adolescents[1,2] with a reported lifetime prevalence of 7–72% and a 1-year incidence of 18–33%.[1,2] LBP can affect adolescents in different ways, it can negatively affect participation in sports and leisure activities as well as daily activities,[3,4] can increase school absenteeism, consequently, interfering with cognitive development and academic performance,[5] and has been associated with chronic LBP later in life.[6,7] Previous longitudinal studies showed that LBP in schoolchildren is associated with female sex,[8–10] smoking,[8,11] obesity,[8,12] history and frequency of pain,[13–15] schooling-related factors (sitting time and schoolbag weight),[8,13] manual work,[13] sleeping difficulties,[9,15] and comorbidities.[14]

Previous studies[2,8,10,13] have been conducted in high income countries, so it is unclear whether these results directly apply to countries like Brazil. The Brazilian context differs from high income countries due to its vast territory, with limited availability of health-related resources and great cultural, socioeconomic, and political diversity.[11] To our knowledge, there has been no studies investigating LBP incidence and associated factors in Brazilian adolescents. Incidence studies focusing on new LBP episodes in adolescents may reveal whether this is a problem in this population. This is particularly important because there is an urgent need for high-quality data on LBP in Brazil.[16] Furthermore, information on LBP risk factors can assist in the identification of potential targets for effective prevention strategies, particularly if these factors are considered to be modifiable. The modifiable risk factors could guide the development of preventive interventions, for instance, in school environment.

Therefore, the objectives of this study were to determine the incidence and identify predictors (sociodemographic variables, use of electronic devices, level of physical activity, and mental health status) of new episodes of LBP in adolescents.

Methods

Study design

This is a longitudinal study using data collected in 2017 as the baseline and in 2018 as the follow-up surveys. This study was approved by the Research Ethics Committee of Universidade do Sagrado Coração, Bauru, SP, Brazil (n°: 1.972.579).

Sample calculation

Adolescents enrolled in the first and second year of secondary education in public schools in the city of Bauru/SP were the study population. According to data provided by the State Department of Education, 9000 students were enrolled in 2017. To determine the sample size, we used the formula for finite populations with the following parameters: 95% confidence level, 50% prevalence, unknown percentage complement (100-p), population size of 9000 high school students from state public schools, and 3% of maximum permissible error. Thus, the total sample size needed was at least 990 individuals, to which we added a 20% expected loss and 15% for association studies, reaching a total of 1366 adolescents. This calculation was done for the prevalence study and those who reported having no low back pain were included in the incidence study.

The sampling technique used was the two-stage cluster sampling, where the primary sampling units (UPA) were the schools and the secondary sampling units (USA) were the classes. The UPA schools were initially stratified by their geographical location in accordance with the division of the city into eight sectors with a total of 30 schools. The same number of schools with classes of 1st and 2nd years of secondary education were selected from each sector.

In each of the eight sectors geographic stratum, the sample was obtained in two stages. First, schools were selected with probabilities proportional to size. Size was defined as the total number of students in the two years of secondary education in each school, and the percentage of each year in relation to the total number of students (*N*= 9000), 36.9% and 33.6%, respectively. These percentages were applied to the total sample (1366 students). Second, the total number of students to be interviewed per sector and per year of high school was determined. To reach the total number of students per sector, the schools were randomly selected, as were the classes of the schools.

Participants

High school students aged between 14 and 18 years, who did not report having LBP at baseline assessment were considered eligible for this study. Students were excluded from the study if they presented with any LBP symptoms at baseline, reported musculoskeletal problems such as fractures in the upper limbs, lower limbs, and trunk, wore a prosthesis, and presented with any other disease that could negatively impact daily activity.

Data collection procedure

In a first contact with the students, in each school, the objectives of the research project as well as the ethical procedures were explained and the informed consent form were distributed to all eligible students. To participate in the study, students were required to take the informed consent form to their parents/guardians and bring the signed form back in the following week. After parental/guardian

consent was provided, baseline data were collected from March to June 2017 by trained assessors. The trained assessors visited each classroom and explained the objective of the study. The assessors also explained to the students that all information would remain confidential throughout the study and that they could leave the study at any time, for any reason. The questionnaires were distributed with instructions for completion, and a time limit of 60 minutes was set for completion of the questionnaires. During this process, any questions raised by the students were promptly answered by the trained assessor. While completing the questionnaire, students were not allowed to talk with other students as a strategy to minimize possible interference with their responses. Follow-up data were collected a year later between March and June 2018 using the same procedures as the baseline assessment.

For each school, three extra visits were made to collect data from students who were absent from classes and three telephone contacts were made to locate those who changed school or moved to another city. Students who changed schools, switched from morning to night classes, had left school, or were not found after three school visits or three telephone contacts were excluded from the analysis. Students who refused to answer the questionnaire by personal choice were considered refusals.

Variable description

The cumulative incidence of LBP (ie, new LBP episodes) was the variable of interest in this study. LBP was coded using the body chart from the Nordic Musculoskeletal questionnaire, which was previously cross-culturally adapted and validated into Brazilian Portuguese. New LBP episode was defined as any episode of pain in the lumbar region, below the costal margin, and above the gluteal fold with or without thigh pain, during the preceding year, not related to trauma or menstrual pain. For the baseline interview in 2017, students answered the following question: "In the last twelve months (until one year ago), did you have pain in some of these regions of the spine (in the areas shown in the body chart)? For the follow-up interview in 2018, students answered the same question but the time frame of the question changed to specifically cover the period of time since the baseline assessment in 2017. For example, if a student was first assessed in March 2017 (baseline interview), the student was interviewed again in March 2018 (follow up interview) with regard to the occurrence of any episode of pain in the lumbar spine between March 2017 and March 2018.

At the time of data collection, in addition to the question, a body chart with the spine regions (lumbar, thoracic, and cervical) highlighted in different colors were presented to allow participants to better identify the location of the pain.[17] The students could mark more than one answer, however, for this study only lumbar spine data were used.

The following independent variables were assessed in 2017 and 2018. For socio-demographic purposes, we collected data on sex, age, marital status, and skin color (classification as defined by the Brazilian Institute of Geography and Statistics [IBGE]).

To collect information on the use of electronic devices,[18] the following questions were asked: “Do you watch television?” (yes/no); “How many times a week do you watch television?” (once or twice, three or four times, five times, more than five times); “How many hours a day do you watch television?” (less than one hour, from one to four hours, more than four hours a day); “Do you use computer?” (yes/no); “What type of computer do you use?” (desktop/laptop/both); “What is the height of your computer screen?” (eyes above the midpoint of the screen, approximately in the middle point of the screen, below the midpoint of the screen); “How many times a week do you use your computer?” (once or twice, three or four times, five times, more than five times); “How many hours a day do you use your computer?” (less than one hour, from one to four hours, more than four hours a day); “What is the eye-to-screen distance while using your computer?” ($<$20 cm, 20$-$25 cm, 25$-$30 cm, $>$30 cm); “Do you use mobile phone?” (yes/no); “In what position do you use the mobile phone?” (standing, sitting, lying down, or semi-lying down); “Average daily time using your mobile phone:” ($<$1 h, 2$-$3 h, 3$-$4 h, and $>$4 h); “What is the eye-to-screen distance during the use of your mobile phone?” ($<$10 cm, 10$-$15 cm, 15$-$20 cm, and $>$20 cm); “Do you use a tablet?” (yes/no); “In what position do you use the tablet?” (standing, sitting, lying down, or semi-lying down); “Average daily time using the tablet:” ($<$1 h, 2$-$3 h, 3$-$4 h, and $>$4 h); “What is the eye-to-screen distance while using the tablet?” ($<$10 cm, 10$-$15 cm, 15$-$20 cm, and $>$20 cm). For the questions "In what position do you use your cell phone or tablet?", participants could choose more than one option. For the purpose of the analysis, each position (standing, sitting, lying down, or semi-lying down) was transformed into a variable and afterwards they were categorized into individuals who used the equipment in this position (yes) and those who did not (no). To measure reproducibility, a pilot study was conducted with 42 high school students who did not participate in the study. A test-retest was used with a 7-day interval protocol, and adequate values were obtained for all questions in the questionnaire (κ range: 0.66-0.88).

To estimate the level of habitual physical activity practice, we used the Baecke Physical Activity Questionnaire, validated for the Brazilian population.[19] This questionnaire contains 16 questions divided into three subscales: physical activity at school; sports practiced outside of school, and free-time activities. The students were divided into quartiles according to their total score, which resulted in the following categories of physical activity: sedentary (1st quartile); moderately active (2nd and 3rd quartiles); and active (4th quartile).[20]

The Strengths and Difficulties Questionnaire (SDQ), validated for the Brazilian population, was used to evaluate the mental health of adolescents.[21] The SDQ contains 25 items grouped in 5 scales (hyperactivity, emotional symptoms, behavior problems, relationship, and pro-social problems) containing 5 items each, 10 of which are about abilities, 14 about difficulties, and one is considered neutral. Each item can be answered as "false", "more or less true," or "true." The score for each of the scales is obtained by summing the scores of the 5 items, generating a score that varies from 0 to 10. Scores for hyperactivity scales, emotional symptoms, behavior problems, and peer relationships are added together to generate a total score for difficulties, ranging from 0 to 40 points. A total score greater than or equal to 20

points is considered "abnormal" (clinical); scores between 16 and 19 points, borderline, and; scores less than or equal to 15 points as normal.[21,22]

Data analysis

Data analysis was performed using the Statistical Package for the Social Sciences version 18.0. To calculate the cumulative incidence [the number of new cases (I) in the period over the number of individuals (N_0) at risk at the beginning of the period (t_0)], two categories were constructed: 0 = individuals without LBP at baseline (T1) and follow-up (T2) interview, and: 1 = individuals with LBP only at the follow-up interview (T2) (Fig. 1). In the logistic regression analysis, individuals without LBP in T1 or T2 (= 0) were compared with students with LBP in T2 only (= 1).[2]

For categorical variables, we calculated absolute and relative frequencies and prevalence ratios (PR) with 95% confidence intervals (CI). To identify the predictors of LBP, the odds ratio (OR) was used as an association measure, both for bivariate analysis and logistic regression. Analyses were performed according to a hierarchical theoretical-conceptual model,[23,24] in which the variables were organized into four levels according to the temporal and causal relationship for new LBP episodes: First level - sex, age, skin color, and socioeconomic and marital status; Second level - mental health; Third level - behaviors with regards to the use of electronic devices and physical activity level. For the first level, all variables (i.e., sex, age, skin color, and socioeconomic and

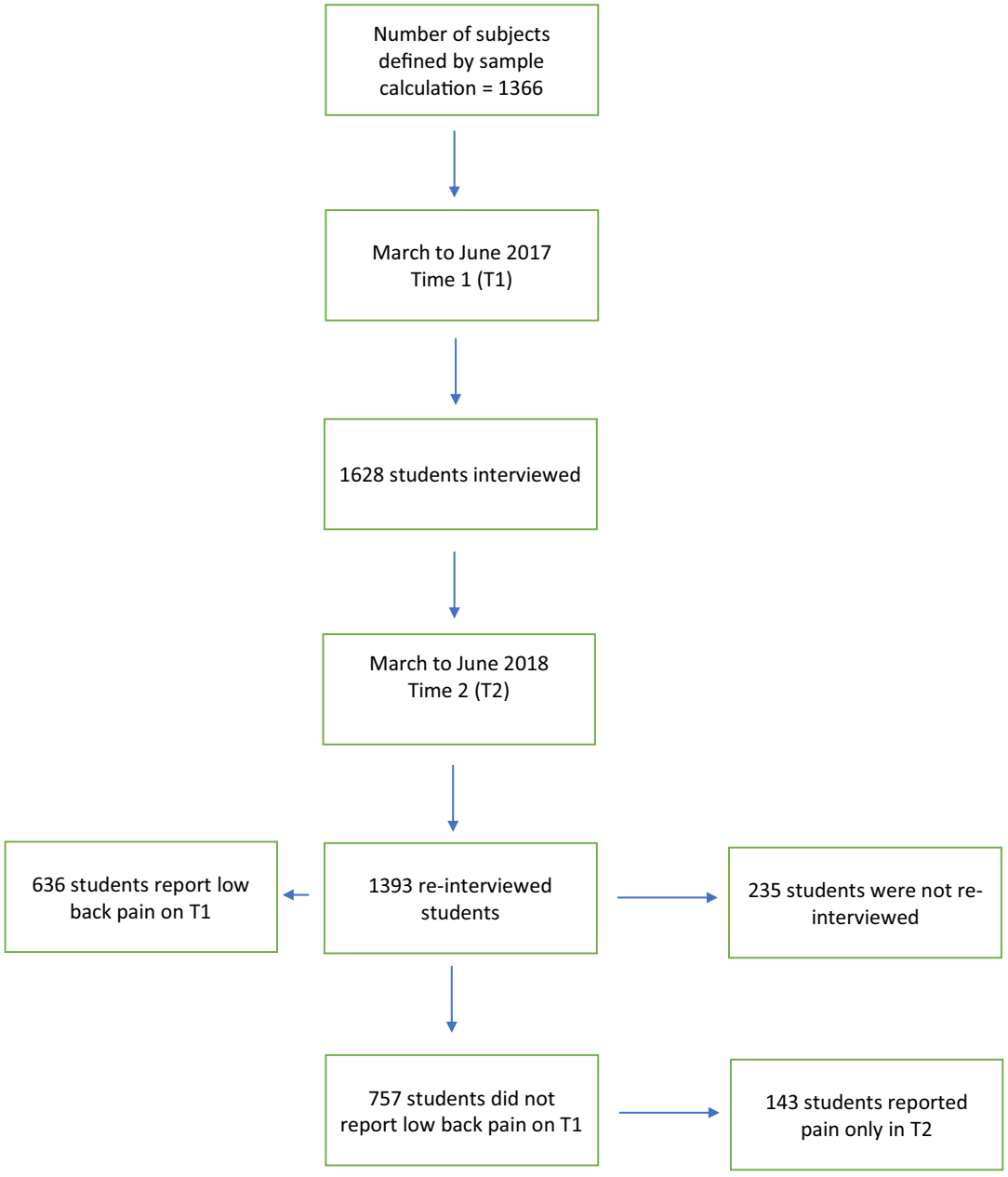

Figure 1 Sample diagram and inclusion and exclusion criteria of the research.

Table 1 Distribution of absolute and relative frequencies of the sociodemographic characteristics, level of physical activity, mental health, and use of electronic devices in high school adolescents by sex.

Characteristics	Sex	
	Male (n = 425) n (%)	Female (n = 332) n (%)
Age		
14 years	59 (13.9)	69 (20.8)
15 years to 18 years	366 (86.1)	263 (79.2)
Marital Status		
Married	15 (3.5)	9 (2.7)
Single	410 (96.5)	323 (97.3)
Skin color**		
White	199 (46.8)	159 (47.9)
Black	55 (12.9)	27 (8.1)
Brown	157 (36.9)	140 (42.1)
Yellow	14 (3.3)	6 (1.8)
Physical activity level		
Active	160 (37.6)	41 (12.3)
Moderately active	189 (44.5)	174 (52.4)
Sedentary	76 (17.9)	117 (35.2)
Mental health status		
Normal	313 (73.6)	161 (48.5)
Borderline	77 (18.1)	93 (28.0)
Clinical	35 (8.2)	78 (23.5)
Television		
Watch television		
No	87 (20.5)	32 (9.6)
Yes	338 (79.5)	300 (90.4)
Frequency (times/ week)		
Up to 2 times	251 (59.1)	202 (60.8)
3 times or more	87 (20.5)	98 (29.5)
Daily time (hours/ day)		
Less than 3 h	201 (47.3)	165 (49.7)
3 h or more	137 (32.2)	135 (40.7)
Computer		
Use computer		
No	74 (17.4)	121 (36.4)
Yes	351 (82.6)	211 (63.6)
Type		
Desktop	202 (47.5)	86 (25.9)
Laptop	122 (28.7)	114 (34.3)
Desktop and Laptop	27 (6.4)	11 (3.3)
Height of the screen		
Eyes above the midpoint	98 (23.1)	42 (12.7)
Eyes at the midpoint	223 (52.5)	143 (43.1)
Eyes below the midpoint	30 (7.1)	26 (7.8)
Eye-to-screen distance		
Up to 30 cm	220 (51.8)	155 (46.7)
30 cm or more	131 (30.8)	56 (16.9)
Frequency (times/ week)		
Up to 2 times	164 (38.6)	148 (44.6)
3 times or more	187 (44.0)	63 (19.0)
Daily time (hours/ day)		
Less than 3 h	137 (32.2)	121 (36.4)
3 h or more	214 (50.4)	90 (27.1)
Mobile Phone		
Use mobile phone		
No	18 (4.2)	6 (1.8)
Yes	407 (95.8)	326 (98.2)
Posture while using mobile phone*		
Standing	151 (35.5)	136 (41.0)
Sitting	228 (53.6)	204 (61.4)
Lying of prone	237 (55.8)	224 (67.5)
Semi-lying	116 (27.3)	139 (41.9)
Daily time (hours/ day)		
Less than 3 h	123 (28.9)	65 (19.6)
3 h or more	284 (66.8)	261 (78.6)
Eye-to-screen distance		
Up to 20 cm	331 (77.9)	301 (90.7)
20 cm or more	76 (17.9)	25 (7.5)
Tablet		
Use tablet		
No	376 (88.5)	281 (84.6)
Yes	49 (11.5)	51 (15.4)
Posture while using tablet*		
Standing	12 (2.8)	16 9 (4.8)
Sitting	29 (6.8)	19 (5.7)
Lying of prone	24 (5.6)	27 (8.1)
Semi-lying	9 (2.1)	17 (5.1)
Daily time (hours/ day)		
Less than 3 h	32 (7.5)	45 (13.6)
3 h or more	17 (4.0)	6 (1.8)
Eye-to-screen distance		
Up to 20 cm	37 (8.7)	48 (14.5)
20 cm or more	12 (2.8)	3 (0.9)

* In the questions the participants could choose more than one option.

** Classification as defined by the Brazilian Institute of Geography and Statistics [IBGE])

marital status) were included in the analysis as covariates. For the second level, the analysis was adjusted by variables from the first level with $p < 0.10$ and the mental health measure. For the third level, the analysis was adjusted for the previous two levels. All the variables that showed $p < 0.10$ in the bivariate analysis entered the hierarchical model

analysis. For the multivariate logistic regression analysis, variables presenting with $p < 0.10$ were considered candidates for the multivariate regression model. To select the variables that remained in the final regression model, the criterion used in the backward selection process was $p < 0.05$.[25]

Results

In 2017 (T1), there were a total of 1628 adolescents eligible from the participating schools. Of these, 41 (2.5%) adolescents refused to answer the questionnaire. In 2018 (T2), of those 1587 adolescents who answered the questionnaire in T1, 138 (8.7%) changed school, moved to another city, switched from morning to night classes or left school and 56 (3.5%) were not found after three consecutive school visits. Thus, the final sample of 1393 adolescents answered the questionnaire in T1 and T2 (Fig. 1).

For the purpose of the incidence analysis, only the results of the 757 students seen at both T1 and T2 and who reported no pain at T1 were analyzed. In 2018 (T2), a total of 143 adolescents (18.9%; 95% CI: 16.2, 21.8), reported having had at least one episode of LBP since T1. The incidence of new episodes of LBP was higher in females (24.1%; 95% CI: 19.8, 28.9) compared to males (14.8%; 95% CI: 11.7, 18.5). Sample characteristics including socio-demographic factors, level of physical activity, mental health, and use of electronic devices are described separately for males and females in Table 1.

The bivariate analyses are presented in Tables 2 and 3. The highest incidence of new LBP case was among adolescent females (OR = 1.62; 95% CI, 1.20, 2.18) and adolescents with clinical mental health issues (OR = 2.21; 95% CI, 1.57, 3.11). Based on the information on use of electronic devices, the highest incidence of new LBP occurred among those who use mobile phones (OR = 1.81; 95% CI: 1.01, 3.33).

For the multivariate logistic regression analysis, adolescent females (OR = 1.78; 95% CI, 1.23, 2.59) was the only variable that remained in the model and was used as a potential covariate for the adjusted analysis in the second level. In the analysis of the second level, clinical mental health problem (OR = 2.81; 95% CI: 1.76, 4.48) remained as significant predictor of new LBP events and was used as a potential covariate along with sex for the adjusted analysis in the third level. The third level showed that sitting while using a tablet (OR = 4.34; 95% CI: 1.19, 16.60), average daily tablet use time in hours (OR = 3.21; 95% CI: 1.41, 7.30) and mobile phone use time in hours (OR = 1.49; 95% CI: 1.11, 2.00) of equal to or more than 3 h, and lying down while using a mobile phone (OR = 1,49; 95% CI: 1.05, 2.12) were significant predictors of new LBP episode (Table 4).

Table 2 Bivariate analysis of the incidence of low back pain with socio-demographic characteristics, level of physical activity, and mental health status in high school adolescents.

Factor	Incidence of low back pain	
	n (%)	OR (95%CI)
Sex		
Male	80 (55.9)	1.00
Female	63 (44.1)	1.62 (1.20, 2.18)
Age		
14 years	26 (18.2)	1.00
15 years to 18 years	117 (81.8)	0.91 (0.62, 1.33)
Marital Status		
Married	6 (4.2)	1.00
Single	137 (95.8)	0.74 (0.36, 1.51)
Skin color*		
White	73 (51.0)	1.00
Black	9 (6.3)	0.53 (0.28, 1.03)
Brown	57 (39.9)	0.99 (0.73, 1.36)
Yellow	4 (2.8)	0.53 (0.20, 1.36)
Physical activity level		
Active	35 (24.5)	1.00
Moderately active	73 (51.0)	1.15 (0.80, 1.66)
Sedentary	35 (24.5)	1.04 (0.68, 1.59)
Mental health status		
Normal	70 (49.0)	1.00
Borderline	36 (25.2)	1.43 (0.99, 2.05)
Clinical	37 (25.)	2.21 (1.57, 3.11)

* Classification as defined by the Brazilian Institute of Geography and Statistics [IBGE]). CI, confidence interval; OR, odds ratio.

Discussion

The main finding of this study was that nearly a fifth of high school students experienced a new LBP episode over a period of 1 year. The risk factors identified as predictors were being female, mental health issues, sitting while using a tablet, lying down while using a mobile phone, and average daily time using a tablet and mobile phone.

The LBP incidence of 18.9% reported in this study is somewhat similar to the ones reported in previous studies conducted in high income countries, such as Australia, Belgium, and England, which ranged from 15.5% to 18.6%.[2,8,10] These studies differ on the time frame of the question. While Szpalski et al.[2] asked whether adolescents had LBP episode in the last year, Jones et al.[8] and Grimmer et al.[10] reported new episode of LBP in the past month and past week, respectively. All previous studies used similarly validated and easy to understand questionnaires including figures that indicate the lower back region but differed with regards to length of the follow-up.

In the current study, female sex was found to be a predictor of new LBP episodes. This finding is consistent with data from other studies[10,26] but not data from Belgiun.[2] The higher incidence found in female adolescents may be due to differences in pain thresholds and hormonal changes induced by puberty.[27] Moreover, LBP may be considered a symptom more easily acceptable when reported by girls, whereas boys tend to omit or deny symptoms associated with LBP.[27,28]

Longitudinal studies that investigated the use of mobile phones and tablets as risk factors for LBP remain scarce. We

Table 3 Bivariate analysis of the incidence of low back pain with electronic devices in high school adolescents.

Factor	Incidence of low back pain			
	Total	n	%	OR (95%CI)
Television				
Watch television				
No	119	23	16.1	1.00
Yes	638	120	83.9	0.97 (0.65, 1.45)
Frequency (times/week)				
Up to 2 times	453	35	24.5	1.00
3 times or more	185	85	59.4	1.019 (0.71, 1.44)
Daily time (hours/day)				
Less than 3 h	366	48	33.6	1.00
3 h or more	272	72	50.3	0.90 (0.65, 1.25)
Computer				
Use computer				
No	195	35	24.5	1.00
Yes	562	108	75.5	1.07 (0.75, 1.51)
Type				
Desktop	288	47	37.1	1.00
Laptop	236	53	5.6	1.37 (0.96, 1.95)
Desktop and Laptop	38	8	32.9	1.29 (0.66, 2.51)
Height of the screen				
Eyes above the midpoint	140	23	16.1	1.00
Eyes at the midpoint	366	77	53.8	1.28 (0.83, 1.95)
Eyes below the midpoint	56	8	5.6	0.86 (0.41, 1.82)
Eye-to-screen distance				
Up to 30 cm	375	72	50.3	1.00
30 cm or more	187	36	25.2	1.00 (0.69, 1.43)
Frequency (times/week)				
Up to 2 times	250	54	37.8	1.00
3 times or more	312	54	37.8	1.24 (0.88, 1.75)
Daily time (hours/day)				
Less than 3 h	304	48	33.6	1.00
3 h or more	258	60	42.0	1.06 (0.75, 1.49)
Mobile phone				
Use mobile phone				
No	24	8	5.6	1.00
Yes	733	135	94.4	1.81 (1.01, 3.33)
Posture while using mobile phone*				
Standing	287	60	42.0	1.29 (0.95, 1.75)
Sitting	432	87	60.8	1.26 (0.91, 1.73)
Lying of prone	461	93	65.0	1.30 (0.93, 1.82)
Semi-lying	255	55	38.5	1.28 (0.94, 1.75)
Daily time (hours/day)				
Less than 3 h	188	26	18.2	1.00
3 h or more	545	109	76.9	1.44 (0.97, 2.14)
Eye-to-screen distance				
Up to 20 cm	632	118	82.5	1.00
20 cm or more	101	17	11.9	0.90 (0.56, 1.43)
Tablet				
Use tablet				
No	657	125	87.4	1.00
Yes	100	18	12.6	0.94 (0.60, 1.47)
Posture while using tablet*				
Standing	28	8	5.6	2.05 (0.90, 4.67)
Sitting	61	15	10.5	3.19 (0.98, 10.32)
Lying of prone	51	12	8.4	1.92 (0.78, 4.71)
Semi-lying	26	6	4.2	1.42 (0.59, 3.40)

Table 3 (*Continued*)

Factor	Incidence of low back pain			
	Total	n	%	OR (95%CI)
Daily time (hours/day)				
Less than 3 h	77	15	10.5	1.00
3 h or more	23	3	2.1	0.66 (0.21, 2.11)
Eye-to-screen distance				
Up to 20 cm	85	15	10.5	1.00
20 cm or more	15	3	2.1	1.13 (0.37, 3.44)

* In the questions the participants could choose more than one option. CI, confidence interval; OR, odds ratio.

Table 4 Multivariate logistic regression analysis for associations of variables with the incidence of low back pain in high school adolescents.

Factor	Incidence of low back pain OR (95%CI)
Sex	
Male	1.00
Female	1.78 (1.23, 2.59)
Daily time spent on mobile phone (hours/day)	
Less than 3 h	1.00
3 h or more	1.49 (1.11, 2.00)
Lying posture while using mobile phone	
No	1.00
Yes	1.49 (1.05, 2.12)
Daily time spent on tablet (hours/day)	
Less than 3 h	1.00
3 h or more	3.21 (1.41, 7.30)
Sitting posture while using tablet	
No	1.00
Yes	4.34 (1.19,16.60)
Mental health status	
Normal	1.00
Borderline	1.55 (0.99, 2.42)
Clinical	2.81 (1.76, 4.48)

*Final regression model all variables with values of $p < 0.05$: 1st Level (sex): adjusted between them; 2nd Level (Mental health): adjusted between them and for the variables 1st Level; 3rd Level (Electronic devices): adjusted between them, for the 1st and 2nd Level variables. CI, confidence interval; OR, odds ratio.

found that sitting while using a tablet, lying down while using a mobile phone and average daily tablet and mobile phone use of equal to or more than 3 h a day were predictors of new LBP episodes. These findings are consistent with those of previous cross-sectional studies[29,30,31,32,33] but differ from the outcomes of a previous longitudinal study.[2] Of note, students included in the current study exceeded the guideline recommendation of less than 2 h of screen time per day.[34] A sedentary lifestyle associated with improper posture can increase the compressive force on the intervertebral discs and lead to a reduced ability of the vertebral disc to maintain a normal concentration of water, influencing the development of degenerative lesions. Also, people with a sedentary lifestyle can have reduced muscle strength and power, resulting in the development of LBP.[29,32]

Another finding from our study was the presence of abnormal mental health increased the risk of new LBP episodes. This finding has also been reported by authors of other studies.[8,10,35] To our knowledge, this is the first longitudinal study to identify risk factors for new LBP episodes in Brazilian adolescents. The mechanism of how screen time and posture while using mobile phones and tablets may lead to LBP include a mix of physical factors, such as increased muscle tension, which possibly affects vertebral tissue nutrition,[36] and psychosocial factors such as decreased coping efficacy, lack of social support, presence of anxiety and depression, and inadequate sleep and exercise habits.[37,38]

The present study has some limitations. First, the data were based on self-reported measures. Students may not have been forthright regarding the duration of electronic device use, as smartphone users tend to underestimate the duration of use.[39] Second, potential confounding factors such as the types of tablets used, previous injuries, and exposure to other technologies were not controlled for in the analysis. Third, we did not measure frequency, severity, pain intensity, and disability, so we are unable to quantify the real impact of the LBP episode on the adolescents. In contrast, methodological strengths include the use of validated questionnaires (Nordic, Baecke and SDQ questionnaire), sampling technique, and the large sample recruited for this longitudinal study.

It is worth noting that this first longitudinal study on the incidence and predictors of LBP episodes in Brazilian high school children can be a call for action for policy makers, parents, and education professionals. Our results show that the incidence of LBP among adolescents is high and should be seen as an important health condition for this age group. Future trials testing preventive and health promotion strategies targeting modifiable risk factors identified in this study are needed.

Conclusion

LBP episodes affects nearly one in five (18.9%) high school children annually and are more common among girls than

boys. Excessive screen time and specific postures while using electronic devices were the factors found to be associated with increased risk of LBP episodes in this population.

Conflict of interest

The authors declare that there are conflicts of interest

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