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Sleep Science

Back and neck pain and poor sleep quality in adolescents are associated even after controlling for confounding factors: An epidemiological study

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ABSTRACT

Objective: Back pain and poor sleep quality are public health issues. Relating to adolescents particularly, the way in which this relationship can occur is still unclear. The aim of this study was to investigate whether low back and neck pain are associated with sleep quality among adolescents. **Material and Methods:** In total, 1011 randomly selected adolescents participated in this study. Neck and back pain were assessed using the Nordic questionnaire, while sleep quality was assessed through the Mini-Sleep Questionnaire. The confounding variables used in the statistical analysis were age, socioeconomic status, physical activity, and body mass index. To analyze the associations between sleep quality and low back and neck pain, multivariate models and binary logistic regression were used. **Results:** 19.9% of the girls reported low back pain while 18.9% reported neck pain. 15.6% of the boys reported low back or neck pain. Regarding low sleep quality, the prevalence was 46.0% for girls and 49.6% for boys. An association was observed between low back pain and sleep quality among girls (OR=1.98 [1.25 – 3.12]) and boys (OR=2.58 [1.48 - 4.50]). An association between neck pain and sleep quality was also observed among girls (OR=2.27 [1.41 - 3.64]) and boys (OR=2.80 [1.59 - 4.91]). **Conclusion:** Low back pain and neck pain were associated with poor sleep quality among adolescents even after the insertion of confounding variables.

Keywords: Back Pain; Students; Adolescent; Sleeplessness.

INTRODUCTION

According to The World Health Organization, back pain is one of the main problems that cause disabilities[1]. Low back pain is estimated to be the leading cause of these disabilities around the world, and the 6th highest contributor to the global burden of disease, indicating a prevalence of 9.4%[2]. Neck pain is also a health problem that causes disabilities, with a prevalence of approximately 5%[3].

Although it is more common for adults to report low back and neck pain, younger populations such as children and adolescents have also reported this kind of musculoskeletal disorder[4]. Silva et al.[5], in a study conducted with 961 boys and girls, observed that 626 (65.1%) reported back pain, being 46.9% thoracolumbar pain and 18.5% neck pain. Notably, it is known that 60% of individuals with low back pain present sleep disturbances[6].

People with both back and sleep disorders seek more care in hospitals than those who only have back disorders[7] and are therefore responsible for generating great demand at the tertiary level of health care. Longitudinal studies have shown that poor sleep quality is associated with pain intensity and functional disability[8] and may also be a factor that makes it difficult to fully recover from intense low back pain and functional disability[9].

Sleep disturbance is a public health issue that has been growing worldwide[10]. It can be influenced by environmental, cultural, and behavioral factors[11] and its prevalence has been estimated as 10 to 48%[12]. Sleep deprivation and sleep disorders can increase the risk of systemic hypertension, overweight/obesity, cardiovascular diseases, and psychological problems, therefore influencing sleep qualitywswswsw as well as quality of life in general[10,11]. Lo[13] observed in a study with 1204 Taiwanese kindergarten children that poor sleeping habits such as watching television or using electronic devices before going to bed, irregular bed time, and insufficient sleep hours can increase the risk of problems such as inattention, daytime sleepiness, and aggressive behavior.

Back pain and poor quality of sleep are both public health problems that are increasing globally. To our knowledge, few epidemiological studies have approached these topics together in the younger population in Brazil, which could provide information for public policies to be elaborated more accurately regarding this topic. Therefore, the aim of the present study was to investigate whether back pain (neck and low back) is associated with sleep quality in adolescents, even after insertion of confounding variables.

MATERIAL AND METHODS

Sample selection and inclusion criteria

There are approximately 37,000 students enrolled in public and private education systems in the city of Presidente Prudente - SP. The city was divided into five regions (i.e., north, south, east, west, and central zone) and a public school was randomly selected from each area so students from different geographical locations of the city could be recruited. Due to the lack of private schools in each area, two private schools were randomly selected that met the proportional number of students of this segment.

To calculate the sample size we used a back pain prevalence rate of 20.7%[14] and the tolerable error was set at 4%. The design effect used was 2.0 and the addition referring to possible sample losses was 20%, generating a minimum necessary number of 946 subjects to be evaluated. To be considered eligible the children and adolescents were required to be between 10 and 17 years of age, be enrolled in public or private schools, and return the consent form signed by a parent or guardian. The study was approved by the Ethics and Research Committee of São Paulo State University (UNESP) (CAAE 21600613.4.0000.5402).

Anthropometry

For anthropometric measurements, body weight was evaluated using a digital scale with a precision of 0.1kg. Height was measured using a portable stadiometer with an accuracy of 0.1 cm. From these two measurements, the body mass index (BMI) was calculated by dividing body weight by the square of the height. All participants were measured barefoot, wearing light clothes.

Back and Neck Pain

The Nordic questionnaire proposed by Kuorinka et al.[15] was used for the assessment of neck and back pain. This questionnaire has been validated for adolescents, obtaining moderate to high values (K=0.57-1.00)[16] and it shows the occurrence of musculoskeletal symptoms (including pain) in different body segments (i.e.. back, neck, low back, elbows, hands, shoulders, hip/thigh, knees. and ankles/feet). Adolescents who reported an episode of neck pain or low back pain in the previous seven days were classified as pain in the demonstrated region.

Sleep Quality

The Mini-Sleep Questionnaire was used to analyze sleep quality[17], this being a validated instrument for the Portuguese language[18]. The questionnaire is made up of 10 questions with seven response possibilities (1 = never; 2 = very rarely; 3 = rarely; 4 = sometimes; 5 = frequently; 6 = very frequently; and 7 = always) and provides a dimensionless score. The sum of these 10 questions is categorized into four categories: good sleep (10-24 points); slight sleep disorder (25-27 points); moderate sleep disorder (28-30 points); and severe sleep disorder (≥ 30 points). Adolescents with a score equal to or greater than 25 points were classified as presenting low sleep quality.

Habitual physical activity practice

Physical activity levels were assessed by the Baecke Physical Activity Questionnaire[19], an instrument that has been translated and its psychometric properties tested in Brazilian adolescents[20]. The questionnaire evaluates habitual physical activity through three different domains: i) physical activity at school; ii) occupational physical activity; iii) and

sports activities outside school (related to sports practice). Total physical activity practice is determined by the sum of these three domains. For each of the three domains and the total score of the questionnaire, the final product is a dimensionless score. Adolescents located in the lowest quartile (Q1) were considered physically inactive for physical activity practice[21].

Use of electronic devices

The information about the hours per day in television, smartphone/tablet, videogame, and computer was collected to determine the use of electronic devices in a typical weekday and in a typical day at weekend.

Socioeconomic condition

The "Brazilian Criteria for Economic Classification", established by the Brazilian Association of Research Companies, was applied to determine the economic condition of the families[22]. The participants completed the questionnaire with the help of an appraiser, considering the level of education and presence and quantity of rooms and possessions in their home (e.g. DVD, PC, bathroom, automobile, motorcycle, washing machine, clothes dryer, dishwasher, domestic servant, microwave, refrigerator, and freezer). The questionnaire establishes the following classifications for economic condition: A1, A2, B1, B2, C1, C2, D, and E.

Statistical analysis

The characteristics of the sample variables are presented as mean and standard deviation. To analyze the associations between sleep quality and low back and neck pain and possible confounding variables (age, socioeconomic status, physical activity, and BMI), we used multivariate models in order to control confounding effects. Multivariate analysis was used to conduct binary logistic regression in which the objective was to determine whether back pain (back and neck pain) was associated with sleep quality even after the subsequent introduction of the variables reported above. Statistical significance was set at 5% and all analyses were performed using SPSS version 15 (IBM SPSS®, Armonk, NY, USA).

RESULTS

In a sample of 1011 adolescents, of which 557 were girls, 111 girls reported low back pain and 105 reported neck pain (19.9% and 18.9% respectively). 71 boys reported low back pain or neck pain (15.6%). The prevalence of low sleep quality was 46.0% for girls and 49.6% for boys. Table 1 presents the characteristics of the sample according to sleep quality. Statistical differences were observed between girls and boys for age, height, and hours per day in electronic devices. Boys with low quality of sleep were lower aged than boys with high quality of sleep.

Table 2 represents the multivariate analysis between low back pain and sleep quality of boys and girls. In the unadjusted analysis, the association between the two variables was significant and this association was maintained even after insertion of the confounding variables in a subsequent manner ($p<0.001$). After the adjustment for the use of electronic devices (Model 4), the association between low back pain and sleep quality lost its significance among girls.

The association between neck pain and sleep quality is presented in Table 3. The results were statistically significant in the analyses of unadjusted models as well as in the adjusted models with the confounding variables inserted sequentially, for both boys and girls ($p<0.001$).

DISCUSSION

Our findings showed that low back pain and neck pain are associated with poor sleep quality in adolescents, independently of the gender. In addition, the prevalence of poor sleep quality demonstrated was very high in both genders. Importantly, insufficient sleep is different among adolescents, considering that they need to wake up early to go to school, sometimes after working during the evening period, which can make this difficult. In addition, many activities after school, including sports, homework, and the use of mobile phones and the internet can reduce total sleep time and contribute to inadequate sleep hygiene[23].

Among the main findings of this study, it was possible to observe that low sleep quality was associated with higher chances of low back pain and neck pain in boys and girls even after adjusting for age, socioeconomic condition, physical activity

Table 1. General characteristics of the sample according to sleep quality.

	Girls LSQ (n=256)	Girls HSQ (n=298)	Boys LSQ (n=225)	Boys HSQ (n=229)
Variables	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Age (years)	13.18±2.32	13.54±2.31	12.71±2.28	13.11±2.46a
Height (cm)	154.90 ±12.73	156.91±11.50	154.65±14.08	156.27±12.79b
Weight (kg)	49.68±15.10	51.19±14.02	48.63±14.75	51.08±15.22
Body mass index (Kg/m2)	20.35±4.43	20.54±4.13	19.98±4.30	20.56±4.29
Physical activity (Baecke's score)	8.90±2.76	8.79±2.76	9.51±2.63	9.43±2.71
Electronic devices in weekdays (h/day)	4.53±3.04	4.91±2.92	5.24±3.38	5.81±3.44b
Electronic devices at weekend (h/day)	4.37±3.03	4.81±3.21	5.27±3.36	5.85±3.53b

PA=Physical Activity; BMI=Body mass index; LSQ=Low sleep quality; HSQ=High sleep quality; SD= standard deviation;
a= Difference between groups; b= Difference between sexes. Electronic devices, hours per day in television, smartphone/tablet, videogame, and computer.

Table 2. Association between low back pain and sleep quality.

Multivariate model	OR	CI (95%)	*p*-value
Unadjusted model girls	2.12	1.36 - 3.30	0.001
Model 1 girls (adjusted by age)	2.00	1.27 - 3.15	0.002
Model 2 girls (Model 1 girls + socioeconomic level)	1.97	1.25 - 3.10	0.003
Model 3 girls (Model 2 girls + physical activity)	1.97	1.25 - 3.10	0.003
Model 4 girls (Model 3 girls + BMI)	1.98	1.25 - 3.12	0.003
Model 5 girls (Model 4 + electronic devices*)	1.38	0.95 – 2.01	0.087
Unadjusted model boys	2.70	1.56 - 4.67	0.001
Model 1 boys (adjusted by age)	2.59	1.49 - 4.49	0.001
Model 2 boys (Model 1 boys + socioeconomic level)	2.61	1.50 - 4.53	0.001
Model 3 boys (Model 2 boys + physical activity)	2.60	1.50 - 4.52	0.001
Model 4 boys (Model 3 boys + BMI)	2.58	1.48 - 4.50	0.001
Model 5 boys (Model 4 + electronic devices*)	2.36	1.48 – 3.75	0.001

Model 1, unadjusted model adjusted by age; Model 2, Model 1 adjusted by socioeconomic level; Model 3, Model 2 adjusted by physical activity; Model 4, Model 3 adjusted by BMI. OR, odds ratio; CI, confidence interval; BMI, Body mass index. *hours per day in television, smartphone/tablet, videogame, and computer in weekdays and at weekend.

Table 3. Association between neck pain and sleep quality.

Multivariate model	OR	CI (95%)	*p*-value
Unadjusted model girls	2.35	1.48 - 3.72	0.001
Model 1 girls (adjusted by age)	2.23	1.40 - 3.56	0.001
Model 2 girls (Model 1 girls + socioeconomic level)	2.18	1.36 - 3.48	0.001
Model 3 girls (Model 2 girls + physical activity)	2.18	1.36 - 3.48	0.001
Model 4 girls (Model 3 girls + BMI)	2.27	1.41 - 3.64	0.001
Model 5 girls (Model 4 + electronic devices*)	1.59	1.10 – 2.30	0.014
Unadjusted model boys	2.92	1.67 - 5.09	0.001
Model 1 boys (adjusted by age)	2.75	1.57 - 4.82	0.001
Model 2 boys (Model 1 boys + socioeconomic level)	2.76	1.58 - 4.84	0.001
Model 3 boys (Model 2 boys + physical activity)	2.75	1.57 - 4.81	0.001
Model 4 boys (Model 3 boys + BMI)	2.80	1.59 - 4.91	0.001
Model 5 boys (Model 4 + electronic devices*)	2.72	1.74 – 4.25	0.001

Model 1, unadjusted model adjusted by age; Model 2, Model 1 adjusted by socioeconomic level; Model 3, Model 2 adjusted by physical activity; Model 4, Model 3 adjusted by BMI. OR, odds ratio; CI, confidence interval, BMI, Body mass index. *Hours per day in television, smartphone/tablet, videogame, and computer in weekdays and at weekend.

level, and BMI. A longitudinal study has shown that insufficient sleep or poor sleep quality are risk factors for neck and back pain independently of sedentary time, depression mood, smoking, BMI, and parents' socioeconomic status, which could possibly be explained by the social pressures, psychological symptoms, and musculoskeletal pain of the adolescents[24].

Another important point concerns obesity among adolescents, considering that young people are spending more time on sedentary behavior activities that do not require much energy. With this change in lifestyle patterns, weight gain is something that becomes inevitable. Obesity among adolescents is becoming a substantial problem, added to which, there is evidence that obesity is associated with poor sleep quality[25] and musculoskeletal pain[26].

Results of a longitudinal study showed that obesity was strongly associated with musculoskeletal pain in adolescents[26]. The relation between pain and obesity can be explained by two main mechanisms. The first mechanism is that the excess of weight causes stress in the musculoskeletal system and the second regards the systemic proinflammatory status worsening widespread and local pain, and, hence, pain is influenced by obesity through sedentary behavior activities causing fear of movement, contributing to more disabilities and increased pain[27].

Another point to consider is sleep quality in adolescents. A prospective study conducted in Finland by Auvinen et al.[24], observed that among girls, in a sample of 1773 adolescents, insufficient quality of sleep increased the prevalence of neck and low back pain, corroborating with our results. Regarding boys, although insufficient quality of sleep also increased the prevalence of neck and low back pain, statistical significance was lost after insertion of adjustment variables.

Epidemiological studies have shown that poor sleep among young populations can be influenced by obesity[28,29]. One theory is that adolescents who present insufficient sleep have high caloric intake and low energy expenditure. Understanding this, sleep restriction usually collaborates in changes in the structure of sleep stage and can influence fatigue, daytime sleepiness, somatic and cognitive problems, and low activity levels[29,30]. In addition, sleep deprivation results in hormonal changes, including leptin and ghrelin[31,32], consequently, mechanisms are

unbalanced by these hormones, which contributes to weight gain[28]. A meta-analysis concluded that short sleep duration increased the risk of obesity in childhood and that sleep is an important factor to prevent obesity in this stage of life[33]. Our findings also showed that obesity is associated with poor sleep quality in adolescents of both genders.

Another mechanism is the relationship between sleep and pain considering that the reduction in sleep duration may contribute to the increase in musculoskeletal pain. The activation of the sympathetic nervous system and inhibition of muscle relaxation, that is, increase in muscle tone and consequently, an increased risk of pain[24]. There is evidence showing that sleep problems increase the risk of injuries by decreasing cognitive function[34]. Our results demonstrated that there was an association between musculoskeletal pain and poor sleep in both genders.

The use of electronic devices mitigated the association of the sleep quality with neck and low back pain in the present study, with loss of significance only for low back pain in girls. The excessive time in screen devices has been associated with poor sleep quality[35] and musculoskeletal disorders[5] in adolescents in the literature. Girls showed lower hours in electronic devices than boys in the present study and future longitudinal studies is suggested to verify the relationship of different electronic devices with low back pain in adolescents, once they correspond to specific domains of sedentary behavior and may be susceptible to a reverse causality, where low back pain could be associated with need to rest and sit, which could lead to higher screen time.

The present study has some limitations that should be considered. Self-reported questionnaires were used to access the information and therefore there is the possibility of reverse causality, however, we emphasize that the questionnaires used are well established in the literature. In addition, it is not possible to infer cause and effect as this study has a cross-sectional design. Nevertheless, information about medication use to treat pain complains was not evaluated in the present study, which could be useful as well as to characterize real pain and may confound the results.

This study also has some strengths, including the randomization of the sample and its representativeness in a large number of adolescents in a developing country. Another factor consists of the control in the analyses for possible confounding factors that might be related to back pain and sleep quality such as age, socioeconomic level, physical activity, BMI, and use of electronic devices.

In conclusion, besides the limitations presented, it is suggested that poor sleep quality was associated with the presence of musculoskeletal pain in both the lumbar and cervical regions. Furthermore, there was a high prevalence of poor sleep quality among adolescents in the public and private education system, regardless of gender.

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