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ARTICLE

Constructs of poor sleep quality in adolescents: associated factors

Os construtos de baixa qualidade de sono em adolescentes: fatores associados

Constructos de calidad deficiente del sueño en adolescentes: factores asociados

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Abstract

This study aims to evaluate factors associated with sleep quality (overall and by domains) in adolescents. A cross-sectional study. This study was conducted with 1,296 first-year high school students from public schools in the Northern Region of the State of Pernambuco, Brazil. Demographic, socioeconomic, and behavioral data were obtained with a questionnaire. Sleep quality was measured using the Pittsburgh Sleep Quality Index *(PSQI) Body mass index (BMI) was calculated based on the ratio of weight and height squared. Multilevel linear and logistic regressions evaluated factors associated with sleep quality. We observed 53% of adolescents reported poor sleep quality. Adolescents at higher risk of clinical depression were 3.45 times more likely to have poor sleep quality (95%CI: 2.04; 5.81), and each additional unit in the social anxiety score presented 1.03 (95%CI: 1.01; 1.05) higher odds of adolescents having poor sleep quality. Adolescents with depressive symptoms had higher sleep latency, greater sleep disturbance, and greater daytime sleep dysfunction. Social anxiety was associated with sleep latency, sleep disturbance, and daytime sleep dysfunction. Higher risk of clinical depression was associated with all domains related to sleep quality. Negative health perception was associated with sleep disturbance, and physical inactivity was associated with daytime sleep dysfunction. Social anxiety and especially higher risk of clinical depression were determinants of poor sleep quality. Changes in sleep latency, sleep disturbance and daytime sleep dysfunction seems to be relevant to poor sleep quality.*

Sleep; Depression; Anxiety; Adolescent

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Introduction

Chronic sleep loss in adolescence has been widely reported in the literature and is considered a public health epidemic [1]. Poor sleep quality causes a general imbalance in the body, especially in the brain chemicals that regulate the sleep-wake cycle, consolidation of memory and body temperature regulation [1]. Poor sleep quality can result in poor quality of life, poor school performance [2], and may even lead to suicidal ideation [3]. Lack of sleep-related physiological restoration may also result in higher levels of stress [4], mnemonic and attention deficits [5], as well as behavioral and emotional problems [6].

Healthy People 2020 [7], a science-based chronogram for improving Americans' health by the year 2020, states that the ideal sleep time during adolescence is at least eight or more hours of sleep a day. In Washington DC (United States), the prevalence of poor sleep quality in young people was 60% [8], while 31% of Saudi adolescents slept less than seven hours/day [9]. Among Brazilian adolescents, 53.6% had a sleep duration of less than 8 hours on school days [10].

Due to the consequences of poor sleep quality, the analysis of the determinants related to sleep during adolescence is significant in order to help design intervention studies aimed to improve the sleep quality of this population. As demonstrated in a meta-analysis, cognitive and behavioral interventions improved sleep quality in school-age children and adolescents [11]. Factors associated with poor sleep quality in adolescents are: having formal employment in addition to studying, concerns over good grades [12], socialization, depressive symptoms, lack of sports practice and other extracurricular activities, increased screen time [13], unhealthy lifestyle [14], and lack of parental monitoring or bedtime rules [15]. More specifically, stressed, anxious, or depressed students are less likely to use adaptive coping strategies, which leads to decreased sleep quality or greater variability in sleep latency [16]. In contrast, optimism seems to be a predictor for good sleep quality [17].

Despite some evidence regarding the determinants of poor sleep quality, it is not well-stablished which factors are associated with sleep quality domains such as latency, insufficiency, disturbance, daytime dysfunction, subjective quality, duration, and use of medication. Therefore, this study aims to evaluate factors associated with sleep quality (overall and by domains) in adolescents.

Methods

Participants

This is a cross-sectional study, part of a project designed to intervene in physical education classes to reduce sedentary behavior and improve cognitive functions – SACODE project (acronym for *Health, Cognition and School Performance*, in Portuguese), which started in 2017. In total, 1,474 first-year students from 11 public high school were eligible to participate in the study; these students dwelled in the area of Vale do Capibaribe in Pernambuco State, Brazil. In the baseline, 1,296 adolescents (572 boys and 724 girls) agreed to participate. SACODE project aimed to evaluate the effects on a multicomponent six-month intervention. Schools staff indicated adolescents who presented physical or cognitive limitations and were excluded from the study. The protocol was approved by the Human Ethics Research Committee of the University of Pernambuco (protocol n. 55741016.0.0000.5207). All parents were informed of the research by signing the Informed Consent Form and the adolescents by the Term of Assent.

Measures

Only variables included in this study will be detailed. Data was collected during March and April in 2017 (spring) by a trained group of researchers comprised of master's and PhD students and PhDs from the University of Pernambuco.

- **Outcome**

Sleep quality was assessed by the *Pittsburgh Sleep Quality Index* (PSQI). This questionnaire consists of 19 individual items, subdivided in seven domains: D1 – subjective quality of sleep (good/bad); D2 – sleep latency – time spent sleeping (numerical scale); D3 – sleep duration (six hours or more/less than six hours); D4 – usual sleep efficiency (numerical scale); D5 – sleep disturbance (numerical scale); D6 – use of sleeping medication (no/yes); D7 – daytime sleep dysfunction (numerical scale). The overall score was calculated [18], ranging from 0 to 21 points and the higher score, the poorer the sleep quality. Sleep quality was categorized into healthy sleep quality (0 - 4 points) and poor sleep quality (> 5 points). The PSQI has been validated for use in Brazilian adolescents [19].

- **Exposures**

Depressive symptoms were evaluated by *The Center for Epidemiological Studies-Depression Scale* (CES-D). This scale only provides a measure of the depressive symptomatology [20], not a diagnosis of depression. A score ranging from 0 to 60 was used, in which a higher score represents higher depressive symptomatology. Participants were classified as low clinical depression risk (0 to 23 points) and high clinical depression risk (> 23 points) [20,21]. Validation studies have demonstrated that CES-D has a good construct and concurrent validity on clinical and self-report criteria, high reliability, and acceptable agreement with clinical ratings of depression [22]. Moreover, CES-D questionnaire was validated for use in the Portuguese language [23].

The *Social Anxiety Scale for Adolescents* (SAS-A) was used to evaluate social anxiety. This questionnaire consists of 26 items [24] and a higher score represents higher social anxiety. A previous investigation validated the Portuguese version of this questionnaire [25].

Anthropometric measures were performed with the adolescent wearing lightweight clothing and barefoot. Three measurements were taken for each adolescent and the mean was used as the final measure. Body mass was measured by calibrated digital scales and height was obtained by portable stadiometers fixed to the wall with an accuracy of 0.5cm. Body mass index (BMI) and body height were calculated by BMI in kg/m^2.

Adolescents who reported performing at least 60 minutes per day of moderate to vigorous physical activity were considered physically active. Adolescents who considered their health as poor or regular were classified as having a poor health perception, while those who considered their health as good or excellent were classified as having a good health perception.

- **Covariables**

A questionnaire was used to obtain information on sex (boys, girls), age and maternal education level (≤ 8 years of education, > 8 years of education), which was used as a measure of socioeconomical status [26].

Statistical analyses

All statistical analyses were conducted in Stata 13 for Windows (https://www.stata.com). Mean, standard deviation and frequency distribution were the procedures adopted to describe numerical and categorical variables, respectively. Multilevel regressions were used to verify the association between depressive symptoms, anxiety, health perception, physical activity, BMI, and sleep quality dimensions: multilevel linear regression was used for sleep latency, usual sleep efficiency, sleep disturbance, and daytime sleep dysfunction; multilevel logistic regression for subjective sleep quality, sleep duration, and use of sleeping medication. In assessing the association of the independent variables listed above with total sleep quality, logistic multilevel regression was also used. None of the associations evaluated were moderated by the sex or the maternal education of the participants. Therefore, analysis are presented for the entire group of participants. All final models were adjusted for gender, age, and maternal education level. In the multilevel regression models, cluster-related variance (school and classrooms) and intraclass correlation coefficient (ICC) were calculated. In the adjusted models the school and class ICCs were below 5%.

Results

The average age of the 1,296 adolescents (44% male) evaluated was 15.02 (± 1.05) years, with 29.87% being aged 13 or 14 years, three individuals aged 20 years and one aged 25 years. More than half of the students' mothers (53%) attended school for less than eight years, 77% of the students reported positive health perceptions, and 37% of the adolescents referred to themselves as physically active. When assessing the adolescents' mental health, 24% of them had a higher risk of clinical depression, while social anxiety had a mean score of 40.6 (± 11.6) points (Table 1). The prevalence of poor overall sleep quality was 53%. When analyzing the PSQI domains, 12% of adolescents had poor sleep quality, 35% slept less than seven hours a night, and 7.4% ingested sleeping medication (Table 1).

Table 1

Socioeconomic and behavioral characteristics of adolescents in the first year of high school.

Characteristics/Category	n (%)
Sex	
Boys	572 (44.14)
Girls	724 (55.86)
Maternal educations level (years)	
< 8	608 (52.60)
≥ 8	548 (47.40)
Health perception	
Good	997 (76.99)
Bad	298 (23.01)
Clinical depression risk	
Low	939 (76.22)
High	293 (23.78)
Insufficiently active	
No	478 (37.00)
Yes	814 (63.00)
Quality of sleep – overall	
Good	339 (46.89)
Bad	384 (53.11)
Domain 1 – quality of sleep	
Good	1134 (87.90)
Bad	156 (12.10)
Domain 3 – time of sleep (hours)	
≥ 6	960 (87.91)
< 6	132 (12.09)
Domain 6 – medication for sleep	
No	1,196 (92.36)
Yes	99 (7.64)
Age [mean (SD)]	15.02 (± 1.05)
Anxiety [mean (SD)]	40.68 (± 11.64)
BMI [mean (SD)]	21.45 (± 4.65)
Domain 2 – sleep latency [mean (SD)]	1.12 (± 0.82)
Domain 4 – usual sleep efficiency [mean (SD)]	0.73 (± 0.39)
Domain 5 – sleep disturbance [mean (SD)]	1.14 (± 0.54)
Domain 7 – daytime sleep dysfunction [mean (SD)]	1.27 (± 0.89)

BMI: body mass index; SD: standard deviation.

Depressive symptoms and social anxiety were associated with poor overall sleep quality in adolescents. Adolescents at higher risk of clinical depression were 3 times more likely to have poor sleep quality (OR = 3.45; 95%CI: 2.04; 5.81) when compared to those at lower risk of clinical depression. Each unit of increase in the social anxiety score presents 1.03 (95%CI: 1.01; 1.05) times more chance for adolescents to have poor sleep quality (Table 2).

Adolescents at higher risk of clinical depression had higher sleep latency (β = 0.33; 95%CI: 0.20; 0.46), more sleep disturbances (β = 0.33; 95%CI: 0.23; 0.43), and more daytime sleep dysfunction (β = 0.46; 95%CI: 0.33; 0.59). Social anxiety was associated with sleep latency, i.e., longer time to sleep (β = 0.01; 95%CI: 0.01; 0.01), sleep disturbances (β = 0.01; 95%CI: 0.01; 0.01), and daytime sleep dysfunction (β = 0.01; 95%CI: 0.00; 0.01). Poor health perception was associated with sleep disturbances (β = 0.02; 95%CI: 0.11; 0.81) and being insufficiently active was associated with daytime sleep dysfunction (β = 0.17; 95%CI: 0.06; 0.28) (Table 3).

Table 2

Multilevel logistic regression of factors associated with poor sleep quality in adolescents in the first year of high school.

Characteristic	Crude regression OR (95%CI)	Adjusted regression * OR (95%CI)
High clinical depression risk	5.62 (3.45; 9.14)	3.45 (2.04; 5.81)
Anxiety	1.04 (1.03; 1.06)	1.03 (1.01; 1.05)
Negative health perception	1.47 (0.99; 2.17)	-
Insufficiently active	1.54 (1.11; 2.14)	1.19 (0.79; 1.77)
BMI	0.99 (0.95; 1.03)	-

95%CI: 95% confidence interval; BMI: body mass index; OR: odds ratio.

* Adjusted by sex, age and maternal education level.

Table 3

Multilevel linear regression of factors associated with different domains (sleep latency, sleep inefficiency, sleep disturbance and daytime sleep dysfunction) that make up sleep quality in adolescents.

Characteristic	Sleep latency		Sleep inefficiency		Sleep disturbance		Daytime sleep dysfunction	
	Crude model β (95%CI)	Adjusted model * β (95%CI)	Crude model * β (95%CI)	Adjusted model * β (95%CI)	Crude model β (95%CI)	Adjusted model * β (95%CI)	Crude model β (95%CI)	Adjusted model * β (95%CI)
High clinical depression risk	0.49 (0.38; 0.60)	0.33 (0.20; 0.46)	0.03 (-0.03; 0.09)		0.47 (0.38; 0.56)	0.33 (0.23; 0.43)	0.66 (0.55; 0.77)	0.46 (0.33; 0.59)
Anxiety	0.02 (0.01; 0.02)	0.01 (0.01; 0.01)	0.01 (-0.01; 0.01)		0.02 (0.01; 0.02)	0.01 (0.01; 0.01)	0.02 (0.01; 0.02)	0.01 (0.00; 0.01)
Negative health perception	0.22 (0.11; 0.33)	0.43 (-0.08; 0.16)	0.01 (-0.05; 0.06)		0.15 (0.06; 0.24)	0.02 (0.11; 0.81)	0.26 (0.15; 0.38)	0.03 (-0.09; 0.16)
Insufficiently active	0.09 (-0.01; 0.18)		-0.02 (-0.06; 0.03)		0.01 (-0.07; 0.09)		0.32 (0.22; 0.42)	0.17 (0.06; 0.28)
BMI	-0.01 (-0.01; 0.01)		0.01 (0.00; 0.01)	0.01 (-0.01; 0.01)	0.01 (-0.01; 0.01)		0.01 (-0.01; 0.01)	

95%CI: 95% confidence interval; BMI: body mass index.

* Adjusted by sex, age, and maternal education level.

These adolescents were also more likely to have subjective quality of poor sleep (OR = 4.52; 95%CI: 2.87; 7.14), sleep duration less than 6 hours (OR = 2.93; 95%CI: 1.82; 4.71), and greater chance of using sleeping medication (OR = 2.95; 95%CI: 1.69; 5.15) (Table 4).

Table 4

Multilevel logistic regression between depressive symptoms, anxiety, health perception, physical activity and body mass index (BMI) and sleep problems in different domains (subjective sleep quality [poor], sleep duration [< 6 hours], use of sleeping medication [yes]) in adolescents.

Characteristic	Subjective quality of sleep		Sleep duration		Use of sleeping medication	
	Crude model	Adjusted model *	Crude model	Adjusted model *	Crude model	Adjusted model *
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
High clinical depression risk	5.64 (3.85; 8.28)	4.52 (2.87; 7.14)	2.62 (1.72; 4.00)	2.93 (1.82; 4.71)	3.94 (2.48; 6.25)	2.95 (1.69; 5.15)
Anxiety	1.04 (1.03; 1.06)	1.02 (0.99; 1.03)	1.01 (0.99; 1.02)		1.04 (1.02; 1.05)	1.02 (0.99; 1.04)
Negative health perception	2.52 (1.74-3.66)	1.43 (0.91; 2.23)	1.19 (0.76; 1.86)		2.62 (1.68; 4.07)	1.65 (0.97; 2.83)
Insufficiently active	1.35 (0.92; 1.97)		0.80 (0.54; 1.20)		1.28 (0.82; 2.02)	
BMI	0.99 (0.96; 1.03)		0.99 (0.95; 1.04)		1.01 (0.96; 1.05)	

95%CI: 95% confidence interval; BMI: body mass index; OR: odds ratio.

* Adjusted by sex, age and maternal education level.

Discussion

This study evaluated the association of health factors and sleep quality in adolescents in their first year of high school. As in other studies [27,28], more than half of adolescents reported poor sleep quality. Higher risk of clinical depression and social anxiety were significant factors associated with poor sleep quality. Changes in sleep latency, sleep disturbance, and daytime sleep dysfunction seem relevant to poor sleep quality.

Higher risk of clinical depression was associated with poor sleep quality. In China, Guo et al. [29] observed sleep problems were more prevalent among adolescents with depressive symptoms. Higher risk of clinical depression was associated with all domains that constitute overall poor sleep quality. Depression scores correlate with functional brain connectivity, including the lateral orbitofrontal cortex (negative thoughts), cingulate cortex (recent memory), and precuneus (consciousness), resulting in overthinking situations and the consequences of negative emotional experience, which interferes with the sleep mechanism impairing its quality [30]. Furthermore, hormonal dysfunctions, which are characteristic of depression, can also alter the sleep-wake cycle, leading to circadian disturbance, sleep-wake irregularity, difficulty sleeping, and staying awake in accordance with the demands of the individual's environment, sometimes resulting in insomnia or drowsiness problems [31].

The association between anxiety and poor sleep quality found in this sample supports findings from previous studies [32,33]. Anxiety, also called anticipatory stress, physiologically interferes with the hypothalamus-pituitary-adrenal axis, altering cortisol and cortisol upon awakening, in turn altering the individual's total sleep time [34]. In analyzing the behavioral factor, we can find social insecurity, family problems, or internet use, which increase anxiety and interfere with sleep latency, favoring sleep disorders such as insomnia that cause poor sleep quality [32,35].

In addition to being associated with total sleep quality, social anxiety and depressive symptoms were also associated with the domains of sleep latency, sleep disturbance, and daytime sleep dysfunction. Increased sleep latency may favor sleep disorders such as insomnia, causing daytime consequences such as fatigue, attention deficits and mood instability [36]. Possible hormonal dysfunctions caused by anxiety and depressive symptoms can alter the sleep-wake cycle, causing changes in sleep. According to the Sleep Institute, non-rapid eye moviment (NREM) sleep and rapid eye miviment (REM) sleep repeat every 70 to 110 minutes with 4 to 6 cycles per night, with the reported sleep changes suggesting that adolescents often woke up during the night, interrupting these cycles [37]. Lying in bed has been reported as a coping and stress compensation mechanism, whereas daytime napping has been associated with increased mental stress, so it is plausible that mental disorders cause daytime fatigue, leading to increased daytime sleepiness in adolescents [38]. Sleep is a state of brain activity, and different mood states such as joy, sadness, and fear generate activating and inhibiting brain waves which cause changes in sleep quality [39]. Considering the above explanation, it is understandable that mental health indicators have been associated to more PSQI domains, in addition to being the only ones associated with overall sleep quality.

Regular physical activity was also associated with sleep quality in other studies [39,40]. Physical activity generates a higher production of melatonin, a hormone linked to the circadian cycle responsible for sleep organization, so people who do physical activity have more consistent sleep and have less dysfunctions during the day such as naps [40]. Other studies also show that individuals who rate their own health as poor also rate their sleep quality as poor [41]. Some diseases may lead to sleep disorders as secondary causes such as depression or pain, or others may cause an increased incidence of sleep apnea and snoring triggered by obesity and metabolic syndrome [42].

The findings of this study should be carefully observed given some of its limitations. The cross-sectional design limits the possibility of determining whether poor sleep quality is a consequence of depressive symptoms and anxiety, or whether there is a mutual relationship between these variables. Nevertheless, we based our analysis on the prerogative that social anxiety and depressive symptoms may expose the adolescents to higher chance of poor sleep quality as supported by the literature [43].

More than half of the adolescents suffer from poor sleep quality. Higher risk of clinical depression and social anxiety were important factors associated with poor sleep quality. Changes in sleep latency, sleep disturbance and daytime sleep dysfunction seem very relevant to poor sleep quality.

Contributors

L. M. L. G. Cavalcanti contributed to the acquisition, analysis and interpretation of data; also drafted and critically revised the manuscript. R. A. Lima, C. R. M. Silva and M. V. G. Barros contributed with design, data analysis and interpretation; also drafted and critically revised the manuscript. F. C. Soares contributed to the conception, design, data acquisition, analysis and interpretation; also drafted and critically revised the manuscript. All authors approved the final text and agreed to be responsible for all aspects of the work.

Additional informations

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Resumo

O estudo buscou avaliar os fatores associados à qualidade do sono (global e por domínios) entre adolescentes. Foi realizado um estudo transversal com 1.296 estudantes de primeiro ano do ensino médio em escolas públicas na Região Norte do Estado de Pernambuco, Brasil. Foram obtidos dados demográficos, socioeconômicos e comportamentais através de um questionário. A qualidade do sono foi medida com o Pittsburgh Sleep Quality Index *(PSQI). O índice de massa corporal (IMC) foi calculado como peso dividido por altura ao quadrado. Os fatores associados à qualidade do sono foram avaliados através da regressão linear multinível e logística. Observamos que 53% dos adolescentes relatavam baixa qualidade de sono. Os adolescentes com risco maior de depressão clínica apresentaram 3,45 vezes maior probabilidade de apresentar baixa qualidade de sono (IC95%: 2,04; 5,81), e cada unidade adicional na escala de ansiedade social apresentou 1,03 vezes maiores chances (IC95%: 1,01; 1,05) de baixa qualidade de sono. Os adolescentes com sintomas depressivos mostraram maior latência do sono, maior transtorno do sono e maior disfunção diurna do sono. A ansiedade social mostrou associação com latência do sono, transtorno do sono e disfunção diurna do sono. O risco maior de depressão esteve associado a todos os domínios relacionados à qualidade. Autoavaliação de saúde negativa esteve associada ao transtorno do sono, e inatividade física esteve associada à disfunção diurna do sono. Ansiedade social, e principalmente risco maior de depressão clínica, foram determinantes na baixa qualidade do sono. Mudanças na latência do sono, transtorno do sono e disfunção diurna do sono parecem ser relevantes para a baixa qualidade do sono.*

Sono; Depressão; Ansiedade; Adolescente

Resumen

El objetivo de este estudio fue evaluar factores asociados con la calidad del sueño (general y por ámbitos) en adolescentes. Se realizó un estudio transversal con 1.296 estudiantes del primer año de escuela secundaria, procedentes de escuelas públicas en la Región Norte del Estado de Pernambuco, Brasil. Se obtuvieron datos demográficos, socioeconómicos y comportamentales, a través de un cuestionario. La calidad del sueño se midió usando el Pittsburgh Sleep Quality Index *(PSQI). El índice de masa corporal (IMC) se calculó de la ratio de peso y altura al cuadrado. Las regresiones logísticas y lineales multinivel evaluaron factores asociados con calidad del sueño deficiente. Observamos que un 53% de los adolescentes informaron de una calidad de sueño deficiente. Los adolescentes con mayor riesgo de depresión clínica fueron 3,45 veces más propensos a tener una calidad de sueño deficiente (95%CI: 2,04; 5,81), y cada unidad adicional en la puntuación de ansiedad social presentaba 1,03 (95%CI: 1,01; 1,05) mayores posibilidades de adolescentes sufriendo por calidad de sueño deficiente. Los adolescentes con síntomas depresivos presentaban mayor latencia de sueño, mayores perturbaciones en el sueño, y mayor disfunción durante el día de sueño. La ansiedad social estuvo asociada con la latencia de sueño, perturbaciones de sueño y disfunción del sueño durante el día. Un mayor riesgo de depresión clínica estuvo asociado con todos los ámbitos relacionados con calidad del sueño. Una percepción negativa de salud respecto a la perturbación de sueño e inactividad física estuvo asociada con un sueño deficiente durante el día. La ansiedad social y, especialmente, un mayor riesgo de depresión clínica fueron determinantes en una escasa calidad de sueño. Los cambios en la latencia del sueño, trastornos del sueño y disfunción del sueño durante el día parecieron relevantes para la deficiente calidad del sueño.*

Sueño; Depresión; Ansiedad; Adolescente

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