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Sleep pattern, obesity and healthcare expenditures in Brazilian adults

Padrões do sono, obesidade e despesas em saúde com brasileiros adultos

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Abstract *The aim of this study was to analyze the relationship between sleep pattern and healthcare expenditures in adults, as well as to identify whether physical activity, biochemical markers and obesity affect this relationship. The sample was composed of 168 adults aged ≥ 50 years attended by two Basic Healthcare Units in Presidente Prudente, SP, Brazil. Health expenditure, sleep pattern, anthropometry, adiposity index, physical activity, metabolic and cardiovascular variables were assessed. Statistical analyses were performed using Kruskal-Wallis, Mann-Whitney and Spearman tests. Sleep disorders were positively correlated to higher costs with medicines and negatively correlated to costs with laboratory tests, even after adjusts by confounders. In addition, healthcare costs were also correlated to physical activity score, blood pressure, obesity and metabolic variables. Severe sleep disorders and high percentage of body fat were associated with increased use of medications. Sleep pattern is correlated to primary care healthcare costs, obesity and physical activity level.*

Key words *Healthcare costs, Sleep wake disorders, Body fat distribution*

Resumo *O objetivo deste estudo foi analisar a relação entre padrão de sono e despesas de saúde em adultos, bem como identificar se atividade física, marcadores bioquímicos e obesidade afetam esse relacionamento. A amostra foi composta por 168 adultos com idade ≥ 50 anos atendidos por duas unidades básicas de saúde em Presidente Prudente, SP, Brasil. Foram avaliadas as despesas de saúde, padrões do sono, antropometria, atividade física, variáveis metabólicas e cardiovasculares. Foram utilizados Kruskal-Wallis, Mann-Whitney e Spearman. Os distúrbios do sono foram correlacionados positivamente com os custos mais elevados com medicamentos e negativamente com os custos com testes laboratoriais, mesmo após ajuste por fatores de confusão. Além disso, os custos de saúde também foram correlacionados ao escore de atividade física, pressão arterial, obesidade e variáveis metabólicas. Distúrbios graves do sono e alta porcentagem de gordura corporal foram associados ao aumento do uso de medicamentos. O padrão de sono está correlacionado com os custos de cuidados de saúde primários, obesidade e atividade física.*

Palavras-chave *Custos de cuidados de saúde, Transtornos do sono-vigília, Distribuição da gordura corporal*

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Introduction

Obesity is a major public health problem that has attracted considerable attention worldwide[1]. The prevalence of overweight and obesity in Brazil was 52.5% and 17.9% in 2014, respectively[2], and this numbers continue to increase year after year. Obesity is associated with modification in several comorbidities, including sleep-related disorders, which also affect cardiovascular and metabolic markers[3,4]. Zanuto et al.[5] found high prevalence of sleep disorders in a sample of Brazilian adults (46.6%), which was associated with overweight and obesity. Hanlon et al.[6] identified that the ratio ghrelin peak / leptin peak increased in patients following restricted sleep, suggesting a change in neuroendocrine signaling, which could promote hunger and less satiety, and as consequence, it would be related to obesity and overweight.

On the other hand, physical activity is recognized to be an important behavior related to health outcomes, mainly because it promotes beneficial changes in body composition[6]. In a recent study, Chen et al.[7] showed that moderate to intense physical activity performed during eight to 12 weeks caused significant reductions in fat percentage (-3.4%), decreased fat mass (-3.1 Kg) and increased lean mass (2 Kg), with effects lasting for four weeks, including in older adults with BMI above 28.1 Kg/m².

Additionally, besides the impact on health, sleep pattern can also affect healthcare costs directly and indirectly[8]. Medical costs associated with sleep disorders account for US$ 146 million per year in the United States and more than US$ 1.5 billion per year in Australia[8-10]. According to Kyle et al.[11], individuals with sleep disorders tend to report excessive sleepiness, fatigue, mood swings, and reduced pain tolerance, which increase the use of medical care and medicine[12]. On the other hand, physical activity is inversely related to healthcare costs[13,14]. According to a Brazilian research, 50% reduction of physical inactivity could save more than 1 billion dollars related to medicines due to the positive effects of physical activity in chronic diseases[15,16]. Therefore, the objective of the present study was to analyze the relationship between sleep pattern and healthcare expenditures in adults, as well as to identify whether physical activity, biochemical markers and obesity affect this relationship.

Methods

Sample

This project was a cross-sectional study conducted in March 2016 in the city of Presidente Prudente. Prior to implementation the study was approved by the Ethics Committee Group from the Faculty of Science and Technology, Sao Paulo State University, Presidente Prudente campus and all subjects were asked to sign a consent form.

Sample size estimation was based in standardized measures of linear relationship (r), in which the minimum sample size of 161 participants granted a statistical power of 80% to detect significant relationships of ≥ 0.21. After the fieldwork, the final sample size was composed of 168 participants.

The sample consisted of adults aged ≥ 50 years of both sexes attended by two Basic Healthcare Units (BHU) located in different regions in the city of Presidente Prudente, SP. BHU are small medical facilities that offer a large variety of primary care services in the Brazilian National Health System (NHS), constituting the most distal level of the NHS. These two BHU were indicated by the Municipal Department of Health according to the location and number of patients attended (the two largest BHU were selected). As inclusion criteria were defined: a) age ≥ 50 years; b) register for at least one year at the BHU; c) have active registration of healthcare service (have performed at least one medical visit in the past six months).

Healthcare expenditures

Annual healthcare expenditure of each participant was estimated including all items registered in the medical records in the last 12 months prior to the interview conducted in this study. The healthcare expenditures were categorized into: medical consultations (all medical specialties), exams (clinical and laboratory tests), medicines (released to the patients according to medical prescription) and overall. After that, all expenditures were computed in the Brazilian currency (Real) and converted to US dollar using the average value of the dollar against the Brazilian currency in the 12 months of 2016 (US$ 1.00 equals to R$ 3.10).

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Sleep pattern

The Mini-Sleep Questionnaire is a self-report of current sleep quality, which is measured by ten questions about the frequency of sleep difficulties. Answer options range from 1 (never) to 7 (always), with higher scores meaning more sleep difficulties. The total score is classified into good sleep (10–24), mild sleep difficulties (25–27), moderate difficulties (28–30), and severe difficulties (>30). The questionnaire was validated for the Brazilian population by Falavigna et al.[17].

Anthropometry and adiposity index

Body mass index (BMI) was calculated using measurements of weight and height[18] and obtained by dividing weight by squared height (kg/m^2). Obesity was defined as BMI ≥ 30 kg/m^2 [19]. Abdominal obesity was assessed using waist circumference (WC) measurements, which was collected following the protocol proposed by Lohman et al.[18]. Body fatness (%) was estimated by bioelectrical impedance analysis (InBody brand model 230 model) according to manufacturer's instructions.

Metabolic and cardiovascular variables

Blood pressure was measured in a seated position at rest and followed the protocol proposed by the VII Brazilian Guidelines for Hypertension[20]. Fasting glucose, triglycerides, total cholesterol, high, low and very low-density lipoproteins (HDL-C, LDL-C and VLDL-C, respectively) were evaluated in the morning after 10 to 12 hours of fasting in a private laboratory (all metabolic variables were expressed in mg/dL).

Domains of physical activity

In the present study, the Baecke et al.[21] questionnaire was used to assess self-reported physical activity. The questionnaire was translated and validated into a Brazilian Portuguese version[22]. The questionnaire presents good reproducibility among Brazilian adults[22,23] and satisfactory validity against doubly labeled water method in elderly subjects[24]. The instrument comprises 16 questions scored on 5-point Likert scales (ranging from never to always/very often) addressing three domains of physical activity: occupational, exercise / sports participation and leisure-time / locomotion physical activity. The sum of these three domains denotes the overall physical activity level. Physical activity scores were calculated for each domain and overall according to instructions in the questionnaire.

Statistical analysis

Descriptive statistics were composed of mean, median, 95% confidence interval (95%CI) and interquartile range (IR). Due to the non-parametric distribution of data, comparisons among groups were performed using Kruskal-Wallis test and Mann-Whitney test. The relationship between healthcare costs and independent variables was assessed by Spearman correlation after logarithmic transformation of the non-parametric variables (expressed as standardized coefficients [*r*] and adjusted by all confounders). Statistical analyses were performed by the software BioEstat (release 5.0) and statistical significance (p-value) was set at 0.05.

Results

The sample was composed of 168 adults of both sexes (52 men [31%] and 116 women [69%]), and the average age was 63.8 ± 8.6 years. Descriptive information of the participants is presented in Table 1.

The prevalence of sleep disturbances was 64.9% (n = 109; categories light, moderate and severe combined). People with the worse quality of sleep presented higher BMI (p-value = 0.003), body fatness (p-value = 0.002), total cholesterol (p-value = 0.015) and healthcare costs related to medicines (p-value = 0.010) (Table 2).

The relationship between healthcare costs and sleep pattern is presented in Table 3. The occurrence of sleep disorders was positively correlated with higher healthcare costs with medicine, and negatively correlated to healthcare costs with to exams. Healthcare costs were also correlated to behavioral, cardiovascular and metabolic variables.

Moreover, the relationship between healthcare costs and sleep disorders was assessed using a multivariate model, and the coefficients were presented as standardized units (Table 4). The relationship between sleep pattern and healthcare costs with exams (r = -0.166 [-0.313 to -0.012]) and medicines (r = 0.213 [0.052 to 0.363]) remained significant even after adjustment by confounders.

Table 1. Descriptive characteristics of the sample (n= 168; Presidente Prudente, SP, Brazil, 2016).

	Descriptive statistics (n = 168)	
	Mean (95%CI)	**Median (IR)**
MSQ score	30.7 (28.8; 32.5)	30 (17)
Physical activity (score)		
Occupational	2.2 (2.1; 2.4)	2.6 (1.1)
Exercise / Sports	1.9 (1.8; 2.1)	1.7 (1.2)
Leisure-time / locomotion	2.1 (2.1; 2.2)	2.2 (0.8)
Overall	6.4 (6.1; 6.6)	6.3 (1.9)
Blood pressure (mmHg)		
Systolic blood pressure	129.8 (126.7; 132.8)	128 (23)
Diastolic blood pressure	76.1 (74.4; 77.9)	75 (14)
Anthropometry / adiposity		
Weight (kg)	72.1 (69.6; 74.5)	72.6 (19.6)
Height (cm)	157.2 (155.9; 158.6)	156.5 (11.5)
BMI (kg/m^2)	29.1 (28.2; 30.1)	28.18 (6.4)
WC (cm)	95.3 (93.1; 97.5)	95.5 (15.5)
BF (%)	38.5 (37.2; 39.8)	38.2 (12)
Metabolic variables (mg/dL)		
Total cholesterol	198.5 (193.1; 204.1)	198.50 (45.4)
HDL-C	45.2 (43.6; 46.8)	43.8 (12.1)
VLDL-C	30.5 (28.1; 32.8)	27.2 (17.6)
LDL-C	122.8 (117.9; 127.6)	121 (38.5)
Triglycerides	151.2 (139.6; 162.9)	131.4 (88.1)
Fasting glucose	106.2 (98.6; 113.8)	91.40 (29.3)
Health care costs (US$)		
Consultations	16.62 (15.7; 18.1)	17.00 (11.3)
Exams	8.03 (5.8; 10.1)	0.00 (17.8)
Medicines	30.01 (24.1; 35.8)	17.8 (29.1)
Overall	54.6 (48.1; 61.3)	44.71 (41.4)

Notes: 95%CI = 95% confidence interval; IR = interquartile range; MSQ = mini-sleep questionnaire; BMI = body mass index; WC = waist circumference; BF = body fatness; HDL-C = high-density lipoprotein cholesterol; LDL-C = low-density lipoprotein cholesterol; VLDL-C = very low-density lipoprotein cholesterol.

Discussion

This cross-sectional study involving patients of the Brazilian National Healthcare System found a high percentage of sleep disorders in this population and identified an important relationship between sleep pattern, behavioral variables and high healthcare expenditures.

Regarding the significant relationship between sleep pattern and physical activity level in leisure-time / locomotion domain, Perrier[25] point out that physical activity may influence the release of serotonin, a fundamental hormone that regulates sleep/wake cycle, and the amount and intensity of physical activity performed have been linked to better sleep quality[25]. In terms of promotion of healthy habits in the Brazilian National Health System, the most relevant aspect of our findings is that habitual physical activity measured in free-living conditions was associated with sleep quality[5], instead of physical exercise protocols performed at laboratorial environments.

On the other hand, when considering the different domains of physical activity, a positive relationship was found between occupational physical activity and healthcare expenditures with medical appointments. The literature has showed that higher levels of physical activity (mainly leisure-time) results in lower healthcare expenditures[16,26], but data with other domains are still conflicting. In fact, adults who accumulate 30 minutes or more in low to moderate-intensity physical activity are more likely to use preventive

Table 2. Variables stratified according to sleep pattern (n = 168; Presidente Prudente, SP, Brazil, 2016).

	Sleep Quality (level of difficult to sleep)			
	Normal (n = 59)	**Lightly-Moderately** (n = 29)	**Severely** (n = 80)	
Physical activity and blood pressure	Median (IR)	Median (IR)	Median (IR)	p-value*
Occupational (score)	2.37 (0.91)	2.62 (0.69)	2.87 (3.13)	0.114
Leisure PE (score)	1.37 (1.31)	1.75 (1.00)	2.00 (1.19)	0.343
Leisure / locomotion (score)	2.37 (0.80)	2.25 (1.00)	2.00 (0.80)[a]	**0.049**
Overall (score)	6.12 (1.40)	6.75 (2.2)	6.62 (2.20)	0.754
Systolic	129.00 (22.00)	133.00 (26.00)	126.00 (25.00)	0.510
Diastolic	74.50 (16.00)	74.00 (14.00)	77.00 (15.00)	0.429
Anthropometry, adiposity and metabolic variables				
Weight (Kg)	72.20 (20.00)	63.90 (19.40)	73.25 (20.70)	0.159
BMI (kg/m^2)	26.89 (5.30)	26.80 (5.30)	30.16 (7.60)[a,b]	**0.003**
WC (cm)	94.30 (16.10)	91.50 (17.30)	98.35 (15.80)	0.081
Body fatness (%)	34.45 (11.90)	38.20 (9.80)	40.80 (11.40)[a]	**0.002**
Total cholesterol (mg/dL)	200.50 (49.30)	181.7 (36.30)	204.40 (39.40)[b]	**0.015**
HDL-C (mg/dL)	41.55 (9.10)	47.00 (11.00)	45.05 (14.30)	0.362
VLDL-C (mg/dL)	28.10 (17.70)	23.50 (12.50)	28.35 (20.60)	0.119
LDL-C (mg/dL)	121.50 (42.10)	108.20 (30.40)	124.55 (34.40)	0.076
Triglycerides (mg/dL)	140.70 (88.70)	117.30 (62.30)	141.10 (101.80)	0.342
Fasting glucose (mg/dL)	90.75 (29.00)	99.90 (41.40)	91.05 (27.50)	0.898
Health care costs (US$)				
Consultations	51.00 (33.57)	51.00 (29.75)	51.00 (34.00)	0.657
Exams	0.00 (21.82)	00.00 (67.66)	0.00 (12.49)	0.083
Medicines	35.91 (66.71)	69.92 (114.09)[a]	62.94 (93.51)[a]	**0.011**
Overall	136.85 (121.99)	118.57 (136.26)	146.21 (146.82)	0.355

Notes: IR = interquartile range; BMI = body mass index; WC = waist circumference; BF = body fatness; HDL-C = high-density lipoprotein; LDL-C = low-density lipoprotein; VLDL-C = very low-density lipoprotein; * = Kruskal-Wallis test; a = denotes difference with normal; b = difference with lightly-moderately.

services offered by the healthcare system[27], which corroborates and could help to understand our findings. Moreover, some labor activities can require high physical demand, without targeting health improvement (no supervision/orientation), which can lead to an increase of the risk of injuries and negative economic outcomes, such as absenteeism and productivity loss.

Another important result was the positive relationship between adiposity and sleep disorders, which agrees with findings from other studies[28-30]. Over the last decades, the prevalence of overweight and obesity increased in adults around the world, while the population has reduced sleeping time and increased time spent in sedentary behaviors[31]. A possible explanation for this relationship would be bad food choices observed in people with poor sleep quality, because people with more time awake are exposed to a higher consumption of food and snacks during the night[6], and sedentary behavior is linked to consumption of unhealthy foods[31]. Similarly, harmful modifications in the release of important hormones related to metabolism are also linked with sleep quality[32]. The relationship between adiposity and quality of sleep can also be used to justify the changes in the lipid and glycemic profile observed among patients with poor sleep quality[33,34].

Concerning the relationship between healthcare expenditures and sleep pattern, studies have shown that adults with sleep disorder usually present higher healthcare expenditures[13,14]. People with insomnia spent 26% more with medical services during a year when compared to people without the disorder[35]. In Canada, Daley et al.[10] estimated that the annual direct costs related to sleep disorders was 509.9 million dollars in 2009.

Table 3. Relationship between health care costs and independent variables in patients attended at primary care of the Brazilian National Health System (n = 168; Presidente Prudente, SP, Brazil, 2016).

	Health care costs (US$)			
	Consultations	**Exams**	**Medicines**	**Overall**
MSQ score	0.088	-0.152*	0.245*	0.142
Physical Activity (score)				
Occupational	0.162*	0.043	0.112	0.128
Leisure physical exercise	0.008	-0.045	0.078	0.009
Leisure and locomotion	0.025	0.085	-0.118	-0.075
Overall	0.144	0.088	0.078	0.096
Blood pressure (mmHg)				
Systolic	-0.060	-0.164*	0.123	-0.012
Diastolic	-0.046	-0.096	0.034	-0.049
Anthropometry / adiposity				
Weight (kg)	-0.009	-0.023	0.034	0.055
BMI (kg/m^2)	0.076	0.023	0.147	0.182
WC (cm)	-0.004	-0.073	0.083	0.050
BF (%)	0.104	-0.052	0.126	0.145
Metabolic (mg/dL)				
Total cholesterol	0.085	-0.075	-0.035	-0.083
HDL-C	0.036	-0.024	-0.126	-0.088
VLDL-C	0.112	0.076	0.273*	0.252*
LDL-C	0.046	-0.111	-0.132	-0.175*
Triglycerides	0.119	0.092	0.264*	0.239*
Fasting glucose	-0.022	0.075	0.181*	0.184*

Notes: * = p-value < 0,005; MSQ = mini-sleep questionnaire; BMI = body mass index; WC = waist circumference; BF = body fatness; HDL-C = high-density lipoprotein; LDL-C = low-density lipoprotein; VLDL-C = very low-density lipoprotein.

The pathways by which poor sleep quality increases healthcare costs are not entirely clear, but could be supported by its linkage with obesity and depressive symptoms. The economic burden associated with sleep disorders has been pointed out as a public health problem in developed countries[10] and the findings of this study indicate that the same pattern seems to be observed in developing countries.

Cross-sectional design constitutes a limitation of this study, because causality statements are not possible. A significant limitation of the study is the use of the questionnaire to evaluate sleep pattern, although other variables could be included as sleep timing, circadian interruption and accumulation of sleep loss and fatigue. About the questionnaire used in this study, the mini-sleep questionnaire has been validated in a younger group, denoting caution in its use in older people. Moreover, due to the non-probability sampling technique (convenience sampling) only two BHU were used in this survey and thus caution is required to any inference of these findings. Another limitation of this study was the non-exclusion of people using sleep medication. The non-exclusion was necessary because economic analyzes were the main outcome of this study, and medication have a great burden on this outcome.

In summary, it was possible to identify that poor sleep quality is positively related to healthcare costs and adiposity, and negatively related to some domains of physical activity. The relationships of low magnitude observed in this study denote that other variables not accounted in these models affect the phenomenon. Thus, future studies should investigate a wide prospectus of variables potentially related to healthcare costs and sleep in Brazilian adults.

Collaborations

EP Silva, APR Rocha, MYC Araujo, BC Turi, RA Fernandes and JS Codogno participated in all stages of article elaboration, from study design, data collection, analysis and interpretation, until the final writing and consequent approval of the final version to be published.

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