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Depressive symptoms and sleep: A population-based polysomnographic study

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ABSTRACT

The goals of the present study were to determine the prevalence of depression in the adult population of Sao Paulo, Brazil and to explore the relationship among sociodemographic, physical and psychological factors, sleep-related symptoms and polysomnography parameters. Participants of a cross-sectional study ($N=1101$) were administered questionnaires and submitted to polysomnography. A score >20 in the Beck Depression Inventory was used to describe depression. Results revealed that the prevalence of depression was 10.9%. Estimates were higher in women and were significantly higher among housewives, non-workers and individuals with lower education and income. A combination of sleep-related symptoms and impaired quality of life was 2.5 times more frequent among depressed than non-depressed. Co-morbid insomnia and anxiety were positively associated to depressive symptomatology. There were no alterations in the polysomnography parameters, in either group. The occurrence of sleep apnea with values on the apnea-hypopnea index ≥ 5 was similar and frequent in both groups (around 30%). The findings suggest that depressive symptoms were associated with low education, low income, severe comorbid symptomatology, and impaired quality of life. Considering the high prevalence of sleep apnea, these results point to potential social and financial burdens associated with the depressive symptomatology and various sleep diagnoses.

1. Introduction

Depression has an estimated 12-month prevalence of 6.6% and lifetime prevalence of 16.2% (Kessler et al., 2003, 2005a, 2005b), it is a significant cause of disability and places a burden on society from both economic and social perspectives (Kessler et al., 2005b).

Comorbid depression is related to significant worsening of existing medical conditions, resulting, for example, in an eight-fold increase in mortality among congestive heart failure patients (Barth et al., 2004, Yates et al., 2004) and a 2.3-fold increase in mortality among type-2 diabetes patients (Katon et al., 2005). On the other hand, sleep-related breathing disorder (SRBD) was shown to increase the risk of developing depression (Peppard et al., 2006, Wheaton et al., 2012).

Common symptoms in depression and general medical conditions are obstacles to establish one diagnosis in the presence of the other. Among the most challenging overlapping complaints are sleep disturbances, such as insomnia or hypersomnia (Ong et al., 2009, Harris et al., 2009). The greater part of depressed individuals report dysfunctional sleep, and sleep disturbance is particularly often the issue that makes patients seek medical help (Mendlewicz, 2009).

Despite the fact that the symptoms of SRBD are similar to the neuro-vegetative features of depression (Ohayon, 2003), sleep problems in depressed individuals are rarely followed by objective sleep evaluations using an overnight polysomnography (PSG). In this regard, PSG evaluations may help to identify sleep issues in depressed patients from a positive history of SRBD (Kushida et al., 2005).

Some symptoms, such as fatigue and sleepiness, usually thought of as indicative of SRBD, may be more likely caused by depression (Harris et al., 2009). Indeed, previous studies have not observed strong associations between SRBD and fatigue or sleepiness (Gottlieb et al., 1999, Kapur et al., 2005). Only a few PSG studies examining the relationship between depression and sleep disorders have been performed, and these studies were usually based on small samples of patients with major depressive disorder (MDD) (Ong et al., 2009,

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Reynolds et al., 1982, Reynolds et al., 1985). There was only one large population-based study, but that did not employ PSG evaluation (Ohayon, 2003).

The Sao Paulo Epidemiologic Sleep Study (Santos-Silva et al., 2009) was implemented to establish the profile of sleep disorders in the adult population of the city of Sao Paulo, Brazil and to examine associations with a vast range of indicators including mood scales. This study examined the frequency of depressive symptoms in the general population, and compared demographic and sleep characteristics, including PSG evaluations, between individuals classified as depressed and non-depressed.

2. Methods

2.1. Setting and participants

A survey was conducted in the adult population of Sao Paulo from July to December of 2007 using a three-stage probabilistic cluster sampling procedure (Korn and Graubard, 1999) to proportionally select a pool of participants according to gender, age (20–80 years) and socioeconomic status. A sample size of 1101 volunteers was determined as allowing for prevalence estimates with 3% precision (Korn and Graubard, 1999). First, 96 districts were proportionally selected from the 1500 that are used to divide Sao Paulo into four homogeneous socioeconomic regions for census purposes (IBGE, 2000). Next, 11 homes from each district were selected. Finally, one individual from each home was randomly selected. If we were unable to contact the individual after three attempts, the home was replaced using the previously established criteria. Pregnant or breastfeeding women and individuals with disabilities who required outside care were excluded. The study protocol was approved by the Ethics Committee for Research of the Universidade Federal de Sao Paulo-UNIFESP (CEP 0593/06) and registered with ClinicalTrials.gov (Identifier NCT00596713). Participants signed written informed consents. The detailed methodology has been previously described (Santos-Silva et al., 2009).

2.2. Procedures

2.2.1. Questionnaires

We used the following questionnaires: the Brazilian Criterion of Economic Classification (ABEP, 2003), the UNIFESP Sleep Questionnaire (Braz et al., 1987), the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989), the Insomnia Severity Index (ISI) (Bastien et al., 2001), the World Health Organization Quality of Life (WHOQOL-BREF) (Skevington et al., 2004), the Chalder Fatigue Scale (CFS) (Chalder et al., 1993), the Beck Anxiety Inventory (BAI) (Beck et al., 1988) and the Beck Depression Inventory (BDI) (Beck et al., 1961).

2.2.2. PSG

Full in-lab PSG was recorded through a digital system device (EMBLA® S7000, Embla Systems, Inc., Broomfield, CO, USA) during the participants' habitual sleep time. Standard montage and criteria for scoring sleep stages were used (Rechtschaffen and Kales, 1968). Arousals, leg movements and respiratory events were scored according to the guidelines from the *American Academy of Sleep Medicine* (Iber et al., 2007).

2.3. Assessments

2.3.1. Depression criteria

The BDI was used to screen depressive symptoms. Its 21 items relate to symptoms of depression such as sadness and loss of interest, thoughts such as guilt or feelings of being punished, as well as physical symptoms such as fatigue, weight loss, sleep disturbance and lack of interest in sex. Each symptom was rated by the respondents on a 0–3 scale, with 0 representing "absence" and 1–3 representing increasing levels of symptoms severity. The BDI yields a total score ranging from 0 to 63, with higher scores indicating greater levels of depressive symptoms. Subjects scoring below 20 were considered as "non-depressed", whereas those scoring above 20 are considered as "depressed" and included as cases for the estimation of the prevalence of "probable major depression" in Sao Paulo. BDI is the most frequently used instrument to assess depressive symptoms in the psychiatric and sleep literature, and it has been validated in different populations since its first publication in 1961 (Beck et al., 1961, Clark et al., 1983, 1997, Johnson et al., 1996, Campbell et al., 1984, Lisspers et al., 1997, Lasa et al., 2000, Kendall et al., 1987).

2.3.2. Reported symptoms

The definitions of the various symptoms are as follows. *Insomnia*: based on the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) general criteria (First et al., 2004), items from the questionnaires were combined for difficulty initiating or maintaining sleep, or early morning awakening that persisted for six months and occurred in the last month, with frequencies of at least three times a week and with extreme interference of daily functioning (First et al., 2004), *Nightmares*: report of waking up anxious after a nightmare in the past 6 months at more than once a week (Braz et al., 1987), *Non-Restorative Sleep*: reports of tiredness upon awakening independently of time slept occurring two or more times a week in the past 6 months (Braz et al., 1987), *Disturbed sleep*: report of agitation as generally present in sleep, in the past 6 months (Braz et al., 1987), *Headache-related awakening* (*HRA*): awakening from a headache more than once a week in the past six months (Braz et al., 1987), *Sleepiness*: excessive daytime somnolence with impairment in performing daytime activities or sleep attacks with sudden fallings asleep, occurring three or more times a week in the past six months (Braz et al., 1987), *Fatigue*: scores equal to or greater than five in the Chalder scale (Chalder et al., 1993), *Sleeping Pills*: taking a medication to promote sleep three or more times a week in the past six months (Braz et al., 1987), *Anxiety*: scores equal to or greater than twenty on the BAI, which indicates moderate to severe symptomatology (Beck et al., 1988), *Poor Quality of Life*: scores lower than fifty for each domain of WHOQOL-BREF (Skevington et al., 2004).

2.3.3. Objective measures

The following variables from the PSG report were compared between groups: sleep onset latency (SOL), total sleep time (TST), sleep efficiency, wake time after sleep onset (WASO), arousal index, stages 1 and 2, slow-wave sleep (SWS), rapid-eye movement (REM) sleep, REM latency, periodic leg movements (PLM) index, percentage of TST with the SpO_2 below 90% ($SpO_2 < 90\%$) and the Apnea and Hypopnea Index (AHI).

2.4. Statistical analysis

The SPSS version 13.0 for Windows was the statistic software used for data analysis. Prevalence estimates were generated using pseudo likelihood maximization. Variability and precision as well as confidence intervals (95% CI) were estimated using Taylor series linearization to avoid underestimation bias (Korn and Graubard, 1999). Descriptive statistics are presented for population and group characteristics. Reliability analysis was used to investigate the internal consistency of the BDI and to calculate Cronbach's alpha coefficient. Cross-tabulations of various factors with depression were examined to evaluate associations. General linear models (GLM) were used for variance analysis of the PSG scores by depression status controlling for age and the AHI (covariates that influence sleep fragmentation and architecture) (Feinberg, 1974). Effect sizes (partial eta squared – η^2) and the power of the multivariate model were also evaluated.

3. Results

From the 1101 selected and interviewed participants, a total of 1042 agreed to visit the Sleep Institute for PSG recordings. There were no significant differences between those not participating ($N=59$) and the participants, indicating no selection bias (Santos-Silva et al., 2009). The mean age was 41.9 ± 14.4 years, and 613 were women, representing 53.5% (95% CI: 48.3–58.7%) of Sao Paulo inhabitants (55.7% before weighing). Most participants were married (66.8%, 62.7%–70.7%), participated in the labor force (75.9%, 71.8–79.6%), belonged to the middle class (65.3%, 59.8–70.3%), and were less than 50 years of age (70.5%, 65.2–75.3%).

3.1. BDI distribution and reliability

Some participants did not complete all of the BDI items. Thus, to avoid selection or measurement bias, they had to be excluded. A total of 917 participants were included in the analysis. The mean BDI score was 9.8 (9.1–10.5), with a median of 8.0, and a mode of 6.0. An acceptable and reliable Cronbach's alpha (87%) was found, with no coefficient corrections when any item was deleted, indicating consistency and good reliability.

3.2. Prevalence and sociodemographic

The prevalence of probable major depression in Sao Paulo was 10.9%. Estimates were slightly higher in women than in men (10.6% versus 7.9%, $p=0.060$), and much lower in the elderly (Table 1). Fig. 1 presents the mean BDI scores according to gender and age (in decades) to illustrate these findings. Among the depressed, there