Insomnia Subtypes and Their Relationship to Excessive Daytime Sleepiness in Brazilian Community-Dwelling Older Adults

Cláudia Hara, MD, PhD; Robert Stewart, MD; Maria Fernanda Lima-Costa, MD, PhD; Fábio Lopes Rocha, MD, PhD; Cintia Fuzikawa, MD, PhD; Elizabeth Uchoa, MD, PhD; Josélia O.A. Firmo, PhD; Érico Castro-Costa, MD, PhD

1Psychiatry Residency Programme – Psychopharmacology Course, Social Security Institute of the Civil Servants of Minas Gerais, Belo Horizonte, Brazil; 2Medical Course of the Faculty of Health and Human Ecology, Vespasiano, Brazil; 3King’s College London (Institute of Psychiatry), London, UK; 4Public Health and Ageing Research Group (PHARG) - Federal University of Minas Gerais Medical School and Oswaldo Cruz Foundation, René Rachou Research Institute, Belo Horizonte, Brazil; 5Psychiatry Residency Programme, Social Security Institute of the Civil Servants of Minas Gerais, Belo Horizonte, Brazil; 6Department of Mental Health, Faculty of Medicine of the Federal University of Minas Gerais, Belo Horizonte, Brazil

Study Objectives: To investigate the association between different types of insomnia as exposures and excessive daytime sleepiness (EDS) as a binary outcome in older Brazilian residents.

Design: The baseline examination of the Bambui Health and Ageing Study (BHAS), which is an ongoing population-based prospective cohort study of older adults.

Setting: Bambui (15,000 inhabitants), a city in the State of Minas Gerais, Southeast Brazil

Participants: All residents aged ≥ 60 years were eligible to take part in the BHAS baseline. Of 1742 residents identified who were ≥ 60 years, 1606 (92.2%) were interviewed and received comprehensive examinations of health status.

Interventions: None

Measurements and Results: EDS was defined as the presence of sleepiness ≥ 3 times per week in the last month, causing any interference in usual activities. All insomnia subtypes were significantly associated with EDS in unadjusted analyses, and these associations were only modestly altered after adjusting incrementally for the other covariates. In a final model, the 3 insomnia subtypes were entered into a fully adjusted model simultaneously to investigate mutual independence, giving prevalence ratios of 1.63 (95% CI 1.14-2.31) for initial insomnia, 2.13 (95% CI 1.48-3.07) for middle insomnia, and 1.36 (95% CI 0.94-1.96) for terminal insomnia. The population attributable fractions for initial, middle, and terminal insomnia on prevalence of EDS were 17.6%, 32.9%, and 9.7%, respectively.

Conclusions: Middle insomnia emerged as the insomnia subtype most strongly associated with EDS. Further research is required to clarify causal pathways underlying this cross-sectional association.

Keywords: Excessive daytime sleepiness, subtypes of insomnia, elderly, community

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INTRODUCTION

Sleep propensity during wakefulness in situations of diminished attention is generally referred to as “excessive daytime sleepiness,” although its definition and measurement have been found to vary substantially. In older persons, complaints of excessive daytime sleepiness (EDS) and insomnia are highly prevalent and are associated with adverse outcomes. EDS is a symptom with high clinical and public health importance because of its impact on older people’s health, safety, and quality of life. The association between general insomnia and EDS has been well established in studies of working-age adults and also recently in an older population. However, the associations between insomnia subtypes and EDS have not been investigated in older people.

The pattern of insomnia is often related to its etiology. Initial insomnia (difficulty in falling asleep at the beginning of the night) is often associated with anxiety disorders, while middle insomnia (difficulty in maintaining sleep) and terminal insomnia (early morning awakening) are often associated with disorders causing pain, adverse general health, and depression.

To date, the only study to investigate the association between insomnia subtypes and daytime sleepiness evaluated working-age adults with obstructive sleep apnea. This association varied according to insomnia subtypes. Participants with repeated wakening during the night had more severe subjective sleepiness, while those with initial insomnia had less daytime sleepiness. No association was found between terminal insomnia and EDS.

The study described here tested hypothesized associations between different types of insomnia as exposures and EDS as a binary outcome in older Brazilian residents, and compared the strengths of these associations after controlling for potential confounders including sociodemographic factors, lifestyle characteristics, mental health, and chronic diseases.

METHODS

The Bambui Health and Ageing Study (BHAS)

The BHAS is an ongoing population-based prospective cohort study of older adults carried out in Bambui (15,000 inhabitants), a city in the State of Minas Gerais, Southeast Brazil. The data presented in this paper were collected at the baseline examination of the BHAS, which is an ongoing population-based prospective cohort study of older adults.

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Address correspondence to: Érico Castro-Costa, MD, PhD, Public Health and Ageing Research Group (PHARG), Federal University of Minas Gerais Medical School and Oswaldo Cruz Foundation, René Rachou Research Institute, King’s College London (Institute of Psychiatry), London, UK, Av. Augusto de Lima 1715, 30190.002 Belo Horizonte – Brazil; E-mail: castro-costa@cpqrr.fiocruz.br

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examination. A detailed description of the study design and methods has been published previously.15

Study Population
All residents aged ≥ 60 years were eligible to take part in the BHAS baseline and were identified through a complete census of the city, carried out by the research team between November and December 1996. Of 1742 residents ≥ 60 years identified, 1606 (92.2%) were interviewed and received comprehensive examinations of health status. Those interviewed and those examined were similar to the total population aged ≥ 60 years with respect to all sociodemographic characteristics considered, including age, gender, number of residents in the household, marital status, and education.15

Excessive Daytime Sleepiness
In this study, the information about EDS was calculated from the response to the following question “During the last month, how often did you feel daytime sleepiness,” collected using a structured and validated sleep questionnaire adapted from a previously Brazilian instrument.16 EDS was defined as the presence of sleepiness ≥ 3 times per week in the last month, causing any interference in usual activities. This interference was determined subjectively by the interviewee answering the following question: “During the last month, has daytime sleepiness caused any impairment (problems) in your usual activities.” Interference was defined as the presence of a self-rated substantial problem.6,16,17

Insomnia
Insomnia was defined as difficulty in falling asleep (initial insomnia), difficulty in maintaining sleep (middle insomnia) and/or early morning awakening (terminal insomnia), ≥ 3 times a week during the previous 30 days, causing any distress during the last 30 days, as previously described.16,18

Covariates
Information on gender, age, marital status, and schooling level (number of complete years of schooling) was obtained in the baseline BHAS interview. Body mass index (weight [kg] divided by height [m²]) was calculated from height and weight measurements; scores > 25 were categorized as overweight. Participants were asked about the following lifestyle characteristics: caffeine consumption (number of cups/day in the previous 12 months), current smoking, and regular physical activity. Current smokers were defined as those who had smoked ≥ 100 cigarettes during their lifetime and were still smoking. Regular physical activity was defined as any exercise during leisure time ≥ 20-30 min, ≥ 3 times a week in the previous 90 days.19 Information about insomnia and the use of hypnotic or sedative medication was collected using the sleep questionnaire previously described. Current use of hypnotic or sedative medication was defined as any number of pills taken in the last month. The Mini Mental State Examination (MMSE) was used as a measure of cognitive function.21,22 The presence of psychological distress, a construct, which includes states of anxiety, depression, and somatization, was defined as a score > 4 on the 12-item General Health Questionnaire (GHQ-12).22 This Brazilian validated version of GHQ-12 has been found to be equivalent to

the 30-item Geriatric Depression Scale (GDS-30) for detecting depression symptoms in this elderly sample.23 Angina pectoris was ascertained using the Rose questionnaire.24 Arthritis was self-reported and defined as a physician diagnosis of arthritis or rheumatism, and/or chronic hand and knee symptoms.25 Diabetes mellitus was defined as fasting blood glucose ≥ 126 mg/dL and/or current treatment for diabetes, following the 2003 American Diabetes Association updated criteria.26 Consistent with the seventh Joint National Committee criteria, hypertension was defined as systolic blood pressure ≥ 140 mm Hg, and/or diastolic blood pressure ≥ 90 mm Hg and/or the use of antihypertensive drugs.27 Stroke was defined as previously reported (CDC, 1994). Functional disability was defined as the inability to perform ≥ 1 of 5 activities of daily living: dressing, eating, walking around inside the house, bathing, and maintaining urinary continence.28

The interviews were carried out by community members with ≥ 11 years of schooling selected by the research team. When a person was unable to participate because of cognitive impairment or some other health reason, a proxy was used (such as a family member or informal caregiver). Proxies were not asked questions that involved personal judgment or subjective self-appraisal (such as the EDS complaint), and therefore this group was excluded for the analyses described in this paper. The interviewers were trained by a psychiatrist with large experience in different countries and cultures (E. Uchoa).15

The BHAS was approved by the Ethics Committee of the Oswaldo Cruz Foundation. All participants (and proxies for participants lacking capacity to provide informed consent due to cognitive impairment or some other health reason) were informed about the objectives and procedures of the project and gave full informed written consent.15

Statistical Analysis
Correlations between insomnia subtypes were tested using Spearman rank correlation coefficients. Unadjusted associations of EDS with sociodemographic factors, lifestyle characteristics, mental health, and chronic diseases were evaluated using Pearson $\chi^2$ tests, $\chi^2$ tests for linear trend, or Student $t$-tests. The same procedures were used to assess associations with the different types of insomnia. Categorical variables were: gender, age, marital status, schooling level, body mass index, smoking, regular physical activity, current use of hypnotic or sedative medication, depressive symptoms, angina, arthritis, diabetes, hypertonies, stroke, and functional disability. Caffeine intake and MMSE scores were treated as continuous variables.

Unadjusted and adjusted prevalence ratios (PRs) were estimated in Poisson regression with robust error variance to assess the association between each insomnia subtype (initial, middle, terminal, or any insomnia) and EDS. First we estimated the crude association, then each of these 4 models was adjusted incrementally for (1) demographic variables (gender, age, marital status, and schooling—considered a priori as potential confounding variables in this study), followed by other potential confounders: (2) lifestyle characteristics (body mass index, caffeine intake, current smoking, regular physical activity) and current use of hypnotic or sedative medication; (3) mental health (cognitive function, common mental disorder); and (4) chronic diseases (angina, arthritis, diabetes, hypertension, stroke) and functional disability.
In a final model, the 3 insomnia subtypes were entered into a fully adjusted model simultaneously to investigate mutual independence. The population attributable prevalence fraction for EDS was then estimated from these models using the STATA for Windows 10.1, whose “aflogit” command estimates the attributable fraction from within the Poisson regression framework, thus enabling confounders to be taken into account. Population attributable prevalence fractions when calculated from prevalence ratios in cross-sectional studies represent the proportion of prevalent EDS that could theoretically be avoided if the exposure (a given insomnia subtype) could be removed from the population, taking into account the effect of the exposure (insomnia) on both incidence and duration of the outcome (EDS), assuming a causal relationship estimated free of confounding.

The STATA Software Package (version 10.1, College Station, TX, USA) was used for all analyses.

Results
Characteristics of the sample are summarized in Table 1. The 1514 participants in this study had a mean (SD) age of 69.9 years.
activity, hypnotic or sedative use, common mental disorders, angina, arthritis, hypertension, functional disability, and lower MMSE scores were significantly associated with most, if not all, insomnia subtypes as can be seen in Table 2.

The prevalence ratios (PRs) for the associations between each insomnia subtype separately and EDS are shown in Table 3. All insomnia subtypes were significantly associated with EDS in unadjusted analyses, and these associations were only modestly altered after adjusting incrementally for the other covariates.

A final model, simultaneously entering the 3 insomnia subtypes in addition to all other covariates, gave rise to prevalence ratios of 1.63 (95% CI 1.14-2.31, P = 0.006) for initial insomnia, 2.13 (95% CI 1.48-3.07, P < 0.001) for middle insomnia, and 1.36 (95% CI 0.94-1.96, P = 0.094) for terminal insomnia.
Table 3—Results of analyses of associations between excessive daytime sleepiness and insomnia subtypes (unadjusted and adjusted prevalence ratios [PRs] estimated by Poisson regression)

<table>
<thead>
<tr>
<th>Insomnia</th>
<th>PR (95% CI) Unadjusted</th>
<th>PR (95% CI) Adjusted¹</th>
<th>PR (95% CI) Adjusted²</th>
<th>PR (95% CI) Adjusted³</th>
<th>PR (95% CI) Adjusted⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>3.48 (2.63-4.61)</td>
<td>3.48 (2.63-4.61)</td>
<td>3.04 (2.24-4.11)</td>
<td>2.44 (1.78-3.34)</td>
<td>2.28 (1.65-3.16)</td>
</tr>
<tr>
<td>Middle</td>
<td>4.04 (3.02-5.39)</td>
<td>3.77 (2.81-5.06)</td>
<td>3.59 (2.64-4.88)</td>
<td>2.93 (2.12-4.05)</td>
<td>2.74 (1.97-3.81)</td>
</tr>
<tr>
<td>Terminal</td>
<td>3.10 (2.31-4.15)</td>
<td>2.79 (2.07-3.76)</td>
<td>2.73 (2.00-3.72)</td>
<td>2.12 (1.53-2.93)</td>
<td>2.17 (1.55-3.02)</td>
</tr>
</tbody>
</table>

¹Adjusted for sociodemographic characteristics (gender, age group, marital status, and schooling level). ²Adjusted for sociodemographic characteristics and lifestyle characteristics (body mass index, caffeine consumption, current smoking, and regular physical activity) and current use of hypnotic or sedative medications. ³Adjusted for sociodemographic characteristics, lifestyle characteristics, and mental health (MMSE score and psychological distress). ⁴Adjusted for sociodemographic characteristics, lifestyle characteristics, mental health, and chronic diseases (angina pectoris, arthritis, diabetes mellitus, hypertension, and stroke) and functional disability.

(not presented). Population attributable fraction (PAF) calculations derived from these prevalence ratios suggested 17.6% of EDS prevalence attributable to initial insomnia, 32.9% to middle insomnia, and 9.7% to terminal insomnia.

Finally, the analyses were repeated for a broader category of EDS—i.e., presence of sleepiness in the last month regardless of interference—which gave rise to similar findings (data not shown). Also, prevalence ratios were re-estimated using logistic regression which again gave similar results (data not shown).

**DISCUSSION**

This paper describes what we believe to be the first investigation of the association between EDS and types of insomnia in community-dwelling older people, taking into account a range of potential confounding factors. In Bambuí, EDS was associated with all three types of insomnia—initial, middle, and terminal—and these associations persisted after controlling for sociodemographic status, lifestyle characteristics, mental health, and chronic diseases. Similar strengths of association were found for all three insomnia categories. However, after entering the three of these insomnia subtypes into the same model, middle insomnia was the strongest correlate with EDS followed by initial and terminal insomnia.

The study had a number of strengths including the large sample size, the high response rate, the use of standardized and validated procedures and instruments, the intensive training of the field and laboratory teams, the set of strict and well-defined clinical diagnostic criteria for chronic diseases, psychological distress (anxiety, depression, and somatization symptoms) and cognitive impairment, and the use of EDS and insomnia definitions in accordance with the International Classification of Sleep Disorders criteria considering the presence, frequency, and distress in usual activities.

However the study has limitations. First, we did not have objective data regarding sleep-wake patterns. EDS and insomnia were self-reported measures dependent upon answers to a questionnaire, and their validity had not been tested against polysomnography. However, although objective measures are desirable, their incorporation into community-based epidemiological studies poses substantial logistical challenges and self-report and interview-based measures remain the most widely used instruments in these studies. Second, other sleep disorders such sleep related breathing disorders, restless legs syndrome, and periodic limb movement disorder were not ascertained. Third, because the analysis was cross-sectional, it is not possible to draw definite causal inferences from the relationships found. This is particularly important for the interpretation of PAF statistics. Although these provide further information on potential impact than prevalence ratios alone (since they take into account relative prevalences of exposures) and were therefore felt appropriate to calculate here, the concept of “attribution” assumes an unconfounded direct causative influence, which clearly cannot be conclusively inferred from cross-sectional data. Finally, it should be borne in mind that, in common with most epidemiological data, no attempt was made to define the cause of EDS or insomnia. All of these may have complex interactions at an individual level and there are limits to the extent to which they can be disentangled at a group level in epidemiological research.

EDS is one of the most frequent sleep complaints in the population and affects 10% to 30% of older adults aged 65 years and older. EDS has been consistently associated with an adverse risk profile including a higher risk of total and cardiovascular mortality in community-dwelling elders. In the very few previous studies, which have been undertaken in this area, inconsistent results have been reported concerning the association between insomnia and EDS. Su and colleagues investigated the presence of “desire to sleep during work and meals” in a sample of 2045 non-institutionalized older individuals aged 65 years or older from an urban community of Taiwan, and found an association between insomnia and EDS even after adjustments for demographic and lifestyle characteristics (cigarette smoking, alcohol drinking, and hypnotics) and health status (chronic diseases, depression, and cognitive impairment). Also, Ohayon and colleagues, investigating normative data on sleep-wake characteristics in 1,026 individuals aged 60 years and older from the metropolitan area of Paris, demonstrated that daytime sleep duration of one hour or more was associated with many factors including insomnia. However, another French study of 2,259 non-institutionalized persons aged 65 years and over, assessing EDS using a cut-off > 10 on the ESS, found an association between terminal insomnia and EDS in unadjusted analysis, which was not sustained after adjustments for demographic characteristics, physical health, and mental disorder.

In the study described here, EDS was strictly defined as the presence of sleepiness three or more times per week in the last month, causing any interference in usual activities. All subtypes...
of insomnia were associated with EDS, with very similar prevalence ratios in separate models. Although the three subtypes of insomnia were not highly correlated variables (rho statistics ranging from 0.36 to 0.39), it is difficult to determine the effect of one independent of the others. However, a final model, where the three subtypes of insomnia were simultaneously entered with all other covariates, indicated differences in the strengths of association between insomnia subtypes and EDS, with the strongest associations for middle insomnia followed by initial insomnia and the weakest association with terminal insomnia. The population attributable fraction for EDS prevalence associated with terminal insomnia was also the lowest (9.3%). Interestingly, our findings in this respect were similar to those from a study of daytime sleepiness in people with obstructive sleep apnea, where the strongest relationship was also found with middle insomnia and the weakest with terminal insomnia, despite the fact that the samples were very different.

Despite the common belief that older people sleep less, surveys examining sleep duration in different age groups have shown that in general, older adults report sleeping around seven hours a night, an amount not very different from that reported by younger age groups. Although sleep architecture changes with age, nearly all age-related changes in architecture occur in early and middle age. Slow wave sleep decreases dramatically from 16 years to approximately 35 years but stabilizes from 60 years onward, as do most sleep parameters. Only sleep efficiency continues to decline with age. While controversy remains about the need for sleep changes with age, it is clear that the ability to sleep decreases with age. While numerous studies have shown that the prevalence of insomnia is higher in older adults than younger adults, after adjustment for comorbidities, the prevalence of insomnia is very low in healthy older adults. It appears, therefore, that insomnia is associated with other age-related conditions, rather than age per se. It is, therefore, utmost importance to make the correct medical and psychiatric diagnoses and treat these problems along with appropriate management of the underlying sleep disturbances in old adults.

Further research is clearly required to clarify the apparent differences in relationships between insomnia subtypes and EDS. For example, it is possible that middle insomnia results in a more substantial reduction in sleep duration or quality (i.e., is more disruptive) than the other two subtypes, accounting for the strongest association with EDS. Also, in the context of an older population, natural reductions in sleep duration, which would be less expected to cause functional deficits, may be more likely referred to in terms of initial or terminal insomnia. Furthermore, comparability with younger populations cannot be assumed because initial and terminal insomnia might have different etiologies and/or impacts in different age groups.

A drawback to research in this area is lack of a universally accepted definition of EDS. Prevalence estimates from studies using different diagnostic criteria yield results that vary so widely that firm comparisons cannot be made. The prevalence in our study was at the low end of the 10% to 30% range usually reported, but this might reflect a more restrictive definition applied—in the case of our study, requiring that the symptom was reported as occurring at least three times per week over the previous month and causing some difficulties in functioning. The use of a broad or narrow definition of EDS would be expected to have a stronger influence on observed prevalence than observed correlates; however, heterogeneity in this cannot be excluded.

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DISCLOSURE STATEMENT

This was not an industry supported study. The authors have indicated no financial conflicts of interest.

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