Objective Prevalence of Insomnia in the São Paulo, Brazil Epidemiologic Sleep Study

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Objective: Using polysomnography, the gold standard for sleep assessment, this study aimed to describe the objective prevalence of insomnia in the São Paulo, Brazil, Epidemiologic Sleep Study cohort of 1,101 adults (20–80 years old).
Methods: Objective insomnia was defined by meeting 1 of the following criteria: sleep onset latency >30 minutes (sleep initiating insomnia), wake after sleep onset lasting >30 minutes (sleep maintenance insomnia), total sleep time <360 minutes and a terminal wakefulness >30 minutes (insomnia with too short duration of sleep or early morning awakening), or a combination of the previous quantitative criteria (mixed disorder). Using validated questionnaires based on Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) criteria, subjective insomnia was categorized into 3 groups: good sleepers, insomnia symptoms, and DSM-IV insomnia.
Results: A total of 1,042 subjects participated in the study (95% response rate). The prevalence of objective insomnia was 32%. The subjective prevalence of insomnia symptoms was 45%, and the subjective prevalence of DSM-IV insomnia was 15%. Sociodemographic factors were similar in both the objective insomnia and the DSM-IV insomnia groups. Age, but not psychiatric symptoms, was predictive of objective insomnia. The subjective criteria were not adequately sensitive (36%) to identify objective insomnia, but were adequately specific (77%) to rule out polysomnography noninsomnia.
Interpretation: The prevalence of objective insomnia assessed by polysomnography was higher than the prevalence of subjective insomnia according to DSM-IV–validated questionnaires. Clinical trials.gov ID: NCT00596713.

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Insomnia is highly prevalent, affecting 10 to 25% of the general adult population in most countries, is associated with numerous physical and psychological diseases, and is a severe economic burden.[1–6] According to general consensus,[7,8] standard evaluation of insomnia relies on subjective assessment of symptoms through a structured clinical interview. Aside from subjective tools, polysomnography (PSG) is the gold standard of sleep evaluation. However, PSG is not recommended in clinical practice for diagnosis and evaluation of insomnia except when other sleep disorders are suspected, such as obstructive sleep apnea (OSA) or periodic limb movement (PLM).

According to the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV), only a small proportion of individuals meet subjective diagnostic criteria. Studies that applied these criteria found less variation

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The study protocol, statistical code, and data set are available from Dr Castro (laura.psisono@gmail.com) for approved individuals.

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in the prevalence of insomnia: 9 to 19%.[1–3,9] However, these subjective tools may not accurately assess complex sleep disturbances. Self-evaluation of the length and quality of sleep is particularly challenging, especially describing criteria such as sleep onset latency (SOL), wake after sleep onset (WASO), and total sleep time (TST). Polysomnography (PSG) is the only tool that objectively measures and evaluates sleep using quantifiable data: TST, SOL, WASO, and percentages of slow wave sleep (SWS) and rapid eye movement (REM) sleep.

Aside from insomnia, recent studies have shown that too short sleep (TST $\leq$ 6 hours per day) over months or years was associated with an increased risk of obesity, diabetes, and hypertension.[10–13] Short sleep could be due to poor sleep hygiene or insomnia, as has been observed in almost $^1/_3$ of cases.[14] However, despite rising concern about short sleep, no epidemiological study has used PSG to assess both TST and insomnia in the general population. Therefore, the goal of our study was to investigate insomnia and TST objectively using PSG in a representative sample of the general population of adults in São Paulo, Brazil.

Subjects and Methods

The frame of this study was the São Paulo Epidemiologic Sleep Study. Using a 3-stage cluster sample proportionally representative of the general population according to gender, age, and socioeconomic status, a total of 1,101 volunteers were selected, allowing prevalence estimates with 3% precision.[15]

For consensus purposes, 96 districts selected at random from the 1,500 districts commonly used to divide São Paulo were categorized into 4 homogeneous socioeconomic regions.[16] Eleven homes from each district were then randomized, and 1 individual per home was randomly selected. If the individual was not available after 3 attempts, the home was replaced using the same criteria. Pregnant or breastfeeding women and individuals with disabilities that precluded self-care were excluded.

The study protocol was approved by the ethics committee of the Universidade Federal de São Paulo (UNIFESP; 0593/06). Participants signed written informed consent. The detailed methodology employed in our study has been described in previous studies of the prevalence of snoring, and the association between TST and metabolic and cardiovascular risks in this cohort, but no data on insomnia have been reported.[17–20]

All participants were interviewed at home by trained professionals and were invited to undergo PSG. One third of participants underwent actigraphy (ACT). Interviews were structured using multiple validated questionnaires on sociodemographics, sleep, and health-related symptoms. Those who agreed to undergo PSG were picked up and dropped off by car at convenient places. Upon arrival at the São Paulo Sleep Institute/Associação Fundo de Incetivo à Pesquisa, participants were interviewed by trained psychologists, underwent physical and anthropometrical measures, and were prepared for PSG by experienced technicians. Subjects had to avoid caffeine after 2 PM and alcohol during the evening of the PSG. Subjects had to go to bed before midnight, respecting usual hours of sleep as best as possible, and had to stay in bed for an average duration of 8 hours.[17–20] This has been defined according to usual PSG protocols from clinical trials in insomnia.[21]

Questionnaires

Only validated questionnaires were used to ensure an accurate description of subjects: Criterion of Economic Classification Brazil,[22] Alcohol, Smoking, and Substance Involvement Screening Test,[23] UNIFESP Sleep Questionnaire,[24] Pittsburgh Sleep Quality Index,[25] Insomnia Severity Index,[26] the Berlin questionnaire (sleep apnea risk),[27] International Restless Leg Syndrome Scale,[28] Chalder Fatigue Scale,[29] Beck Anxiety Inventory (BAI),[30] and Beck Depression Inventory (BDI).[31] Specific routines of the sleep laboratory have been previously described.[32]

Based on these questionnaires and interviews, several comorbidities were identified: psychiatric symptoms (BAI and/or BDI scores $\geq$ 20), overweight (body mass index [BMI] $\geq$ 25), obesity (BMI $\geq$ 30), hypertension (individuals prescribed antihypertensive medication and/or reported high blood pressure [BP] readings [systolic BP $>$ 140mm/Hg and/or diastolic BP $>$ 90mmHg]), and cardiovascular events (history of myocardial infarction and/or stroke diagnosed by a physician).

PSG

Laboratory-based PSG was recorded with a digital system device (S7000; Embla Systems, Thornton, CO) during participants' habitual sleep time. Standard montage and criteria for scoring sleep stages were used.[33] Arousals, leg movements, and respiratory events were scored according to guidelines provided by the American Academy of Sleep Medicine.[34]

ACT

ACT was performed to control for PSG first night effect (sleep disturbances due to sleeping in the sleep laboratory for the first time) in a subgroup of subjects. Due to the limited number of actigraph devices, it was randomly decided that 1 in 3 subjects would undergo ACT, and ACT was not systematically performed on the same days as PSG. Data were recorded with a sensor placed on the nondominant wrist, similar to a standard wristwatch

(Actiwach 64; Respironics, Carlsbad, CA). Data analysis (Actiware 5.0 software; Philips Respironics, Bend, OR) assessed parameters of the activity/rest cycle related to PSG (SOL, WASO, sleep efficiency [SE], and TST), which were later compared and validated using sleep diaries.[35] Individuals who agreed to wear actigraphs had sensors and instructions delivered to their homes and were asked to wear actigraphs for at least 3 consecutive days.

Subjective Criteria for Insomnia

Individuals without regular insomnia symptoms were classified as good sleepers. Individuals reporting regular insomnia symptoms (difficulties initiating sleep or SOL- ≥ 30 minutes, difficulty maintaining sleep and/or early morning awakenings, occurring at least $3\times$ per week) that had little or no effect on daytime activities were classified as having insomnia symptoms. Individuals reporting frequent and persistent insomnia symptoms (lasting $\geq$1 month) that interfered "much" or "extremely" with daily functioning were categorized as DSM-IV insomnia.[36]

Objective Criteria of Insomnia: PSG and ACT

PSG criteria for insomnia were based on International Classification of Sleep Disorders-2 qualitative criteria,[7] and literature-based quantitative criteria.[8–12] Objectively, insomnia was defined by 1 of the following 4 options: SOL ≥ 30 minutes (sleep initiating insomnia), WASO ≥ 30 minutes (sleep maintenance insomnia), TST ≤ 360 minutes, and terminal wakefulness ≥ 30 minutes (insomnia with too short duration, insomnia with early morning awakening), or a combination of the previous quantitative criteria (mixed disorder). Based on PSG findings, PSG insomnia (PSG-I) and PSG noninsomnia (PSG-NI) groups were defined. Actigraphy insomnia (ACT-I) and actigraphy noninsomnia groups were also considered.

In addition to the previous parameters, PSG also recorded the duration of each sleep phase as a percentage of TST, REM latency (time from sleep onset to the first appearance of REM sleep), and SE (ratio of TST:time in bed).

Statistical Analysis

Estimates were generated using pseudolikelihood maximization. Variability, precision, and 95% confidence intervals (CIs) were calculated using Taylor series linearization to avoid underestimation bias.[15] Cross-tabulations applied generated crude odds ratios (ORs). A general linear model was used to analyze the questionnaires and PSG parameters, and to identify possible psychiatric symptoms and age as confounders. Bonferroni and Games–Howell (nonhomogeneous) post hoc tests were also used. Effect size (partial eta^2) and observed powers were controlled to avoid type I or type II errors. Two hierarchical diagrams of frequencies were built in which the first level combined subjective and objective insomnias. In 1 diagram, the second level factored in psychiatric symptomatology, whereas the other diagram combined this with OSA. A logistical model was applied to investigate factors with a higher probability of predicting PSG-I. Finally, sensitivity and specificity were calculated to estimate the precision and accuracy of subjective insomnia criteria as a diagnostic test predicting objective outcome.

Results

Subjective Prevalence of Insomnia and Sociodemographics

Of the initial 1,101 interviewed participants, 1,042 individuals agreed to undergo laboratory-based PSG (95%) and 362 (100% of subjects randomly selected) agreed to ACT for an average of 5 ± 1 days (Table 1). This set of participants was representative of the total sample in gender and age distributions, but presented significantly higher socioeconomic status (chi-square = 10.3; $p = 0.006$) and higher educational status (chi-square = 14.8; $p = 0.002$).

The prevalence of subjective insomnia symptoms was 44.8% (95% CI = 40.7–49.0). This group consisted mostly of nonworking females, aged $\geq$40 years, with less education than those defined as good sleepers. The prevalence of subjective DSM-IV insomnia was 15.0% (95% CI = 12.0–18.5). Compared to subjective good sleepers, individuals with DSM-IV insomnia were mostly young adult females with unfixed work, shift work, or no work, with less education, and of lower socioeconomic status.

Comorbidities

The percentage of overweight individuals differed significantly among individuals with insomnia symptoms and DSM-IV insomnia compared with good sleepers. The prevalence of hypertension was significantly higher in both groups of individuals with insomnia symptoms (33.2%) and DSM-IV insomnia (23.4%) compared to good sleepers (15.6%; $p < 0.0001$). Psychiatric symptoms were also more frequent in groups of individuals meeting criteria for insomnia symptoms (18.3%) and DSM-IV insomnia (37.6%) than in the group of good sleepers (8.2%; $p < 0.001$).

Other Subjective Sleep Complaints and Disorders

Sleep habits differed significantly between individuals complaining of insomnia and those not complaining of insomnia (Table 2). Short sleep (TST ≤ 6 hours) was significantly more frequent among individuals with

TABLE 1. Weighed Frequencies (%) and SEs of Sociodemographic Characteristics in Each Subgroup (N = 1,101)

Characteristic	Good Sleepers, 37.2%, n = 410		Insomnia Symptoms, 44.8%, n = 526		DSM-IV Insomnia, 15.0%, n = 165		p[a]
	%	SE	%	SE	%	SE	
Gender, women	47.3	3.7	53.2	3.1	71.4	4.9	0.001
Age, yr							
20–29	31.0	3.4	21.5	2.7	20.2	3.9	0.002
30–39	25.5	2.4	19.5	2.3	34.7	5.4	
40–49	22.1	2.5	20.9	1.9	19.2	4.1	
50–59	11.8	2.3	18.4	2.3	16.8	4.2	
60–80	9.6	1.4	19.6	3.2	9.1	3.5	
Socioeconomic status							
High	31.6	3.6	27.2	3.3	13.7	3.6	0.005
Mid	62.4	3.8	63.2	3.1	79.1	4.0	
Low	5.9	1.6	9.6	2.0	7.3	1.8	
Work shift and status							
Daytime	66.9	3.1	52.7	3.7	52.2	6.2	0.037
Night/alternating	10.1	2.5	11.0	1.9	9.0	3.0	
Unfixed	4.1	1.1	6.8	1.9	12.1	4.2	
Nonworker[a]	18.8	2.3	29.6	3.2	26.7	4.9	
Education, <9 years	28.9	2.9	42.2	3.7	43.6	5.5	0.009

[a]Housewives, retired, and unemployed.
DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, 4th edition; SE = standard error.

insomnia symptoms and individuals with DSM-IV insomnia than among good sleepers. DSM-IV insomnia was also significantly associated with increased sleepiness, awakening headaches, and use of sleeping pills, but lower rates of restless leg syndrome (RLS).

Objective Prevalence of Insomnia according to PSG and ACT

The objective prevalence of insomnia was 32% (95% CI = 27.6–35.9; 329 of 1,042 subjects) according to PSG compared to 27% (95% CI = 24.0–31.5; 98 of 362 subjects) according to ACT.

Analysis of variance of repeated objective measures found a significant difference between ACT and PSG when evaluating TST in the total group (PSG TST = 342.1 ± 77.7 minutes and ACT TST = 366.7 ± 63.4 minutes; $p = 0.001$). SE remained similar across all measures (81.6 ± 6.3 vs 81.6 ± 6.4; $p = 0.22$). Total wake time did not differ between PSG and home ACT groups (71.5 ± 1.8 minutes vs 71.9 ± 3.4 minutes; $p = 0.122$).

To evaluate potential first night effects of PSG, we compared the values of SOL, WASO, TST, and SE observed in ACT and PSG in each subgroup (good sleepers, insomnia symptoms, DSM-IV insomnia, and PSG-I). Respective characteristics of TST, SE, and WASO in individuals with insomnia symptoms, those with DSM-IV insomnia, and good sleepers are presented in Table 3.

Overall analysis suggested that PSG TST and SE were not significantly different between PSG and ACT in the group of subjects with insomnia.

Objective versus Subjective Results

PSG parameters of objective PSG-I and subjective insomnia symptoms, DSM-IV insomnia, and good sleepers are presented in Table 4. Compared to good sleepers, the groups of individuals with insomnia symptoms and DSM-IV insomnia had a longer SOL; however, TST, WASO, SE, and the percentage of REM sleep and SWS did not differ.

TABLE 2. Weighed Frequencies and SEs of Associated Subjective Sleep Complaints and Disorders (N = 1,101)

	Good Sleepers, 37.2%, n = 410		Insomnia Symptoms, 44.8%, n = 526		DSM-IV Insomnia, 15.0%, n = 165		p[a]
	%	SE	%	SE	%	SE	
Reported sleep pattern							
TST < 6 hours	12.6	1.8	22.9	2.2	46.5	5.4	<0.001[a]
Bed midnight or later	17.5	2.8	15.2	1.8	26.3	4.9	0.073
Awake 8 AM or later	20.6	2.5	26.9	2.3	36.1	4.4	0.009[a]
Reported complaints and disorders							
Sleepiness	10.2	1.8	10.7	2.1	34.5	4.4	<0.001[a]
RLS	5.9	2.0	5.4	1.2	9.9	3.6	0.409
Headache awakening	2.5	1.3	10.6	1.6	18.0	4.6	0.001[a]
Sleeping pills	1.8	0.8	4.6	1.1	12.0	3.0	<0.001[a]

[a]Statistically significant.
DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, 4th edition; RLS = restless leg syndrome; SE = standard error; TST = total sleep time.

TABLE 3. Objective Values of Total Wake Time, TST, and Sleep Efficiency in Good Sleepers, Subjects with Insomnia Symptoms, and Subjects with DSM-IV Insomnia in Those Who Had Actigraphy (n = 362) and PSG (n = 1,042)

	Total		Good Sleepers		Insomnia Symptoms		DSM-IV Insomnia		p[a]
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Actigraphy									
Total wake time	71.9	3.4	67.9	3.4	75.4	2.9	85.0	4.1	0.010
Sleep efficiency	81.6	6.4	82.4	6.5	80.3	5.7	79.3	6.0	0.025
Total sleep time	366.7	63.4	370.3	67.3	360.2	65.7	356.9	52.1	0.90
PSG									
Total wake time	71.5	1.8	66.5	3.4	86.3	2.1	77.1	1.3	<0.001
Sleep efficiency	81.6	6.3	84.1	6.8	79.5	5.7	81.7	5.7	<0.001
Total sleep time	342.1	77.7	349.9	74.1	335.2	67.5	340.0	58.8	0.005

DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, 4th edition; PSG = polysomnography; SD = standard deviation; SE = standard error; TST = total sleep time.

Compared to PSG-NI, PSG-I had a longer SOL, WASO, and arousal index, but a shorter TST. These results were expected based on how PSG-I subjects were defined. PSG-I individuals also had a lower percentage of REM sleep and a longer REM latency with no difference in SWS.

Compared to groups with insomnia symptoms and DSM-IV insomnia, PSG-I had a longer SOL, WASO, and arousal index but a shorter TST and SE, which were also expected due to selection criteria. REM latency was longer, and percentage of REM sleep was reduced. The percentage of SWS and the PLM index did not differ.

Five percent of subjects with insomnia symptoms, compared to 2% of noninsomnia subjects (OR = 2.3, 95% CI = 1.3–5.9; $p < 0.01$) and 12% of individuals with DSM-IV insomnia (OR = 6.5, 95% CI = 2.9–14.5;

TABLE 4. Covariates, Means, and SEs of Polysomnographic Parameters in Subjective and Objective Insomnia Subgroups (n = 1,042)

	Subjective Insomnia			Objective Insomnia	
	Good Sleepers, Mean (SE)	Insomnia Symptoms, Mean (SE)	DSM-IV Insomnia, Mean (SE)	PSG-NI, Mean (SE)	PSG Insomnia, Mean (SE)
SOL	12.7 (1.0)	18.0 (0.9)[a]	18.5 (1.6)[a]	8.9 (0.7)	32.2 (0.9)[a,b]
REM latency	100.7 (2.7)	102.3 (2.4)	99.9 (4.3)	92.5 (2.0)	119.4 (2.6)[a,b]
TST	353.8 (3.8)	337.7 (3.3)	342.0 (6.0)	364.0 (2.5)	300.4 (3.4)[a,b]
WASO	50.5 (2.2)	61.2 (1.8)[a]	55.1 (3.4)	34.3 (1.2)	96.6 (1.6)[a,b]
Sleep efficiency	85.0 (0.6)	80.5 (0.5)[a]	82.5 (0.9)	88.2 (0.3)	69.6 (0.4)[a,b]
Stage 1	4.4 (0.2)	4.6 (0.1)	4.3 (0.3)	3.8 (0.1)	5.6 (0.2)[a]
Stage 2	54.8 (0.5)	54.3 (0.4)	54.6 (0.7)	53.7 (0.4)	55.9 (0.5)[a]
SWS	21.8 (0.4)	22.0 (0.4)	21.8 (0.6)	22.1 (0.3)	21.4 (0.4)
REM	19.1 (0.3)	19.1 (0.3)	19.3 (0.5)	20.4 (0.2)	16.7 (0.4)[a,b]
Arousal index	14.6 (0.4)	15.1 (0.4)	12.9 (0.7)[a]	13.3 (0.3)	16.8 (0.4)[a,b]
PLM index	0.7 (0.4)	1.4 (0.3)	1.7 (0.6)	0.8 (0.3)	1.9 (0.4)[a]

Covariates in the model were evaluated at the following values: age = 42.3 years; apnea–hypopnea index = 8.0.
Average values and SD of good sleepers have been compared to those of subjects with insomnia symptoms and those of subjects with DSM-IV insomnia. Then they have been compared between subjects with PSG insomnia compared to those with PSG-NI.
SOL cutoff = 30 minutes; WASO cutoff = 60 minutes; TST cutoff = 360 minutes; sleep efficiency cutoff = 85%.
[a] $p < 0.01$
[b] $p < 0.05$.
DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, 4th edition; NI = noninsomnia; PLM = periodic leg movement; PSG = polysomnography; REM = rapid eye movement; SE = standard error; SOL = sleep onset latency; SWS = slow wave sleep; TST = total sleep time; WASO = wake time after sleep onset.

$p < 0.01$) were taking sleeping pills on a regular basis. PSG-I individuals were also taking sleeping pills more regularly than PSG-NI individuals (7% vs 4%; OR = 1.7, 95% CI = 1.0–2.9; $p < 0.05$).

The Figure 1 describes how psychiatric symptoms correlated with groups of objective and subjective insomnia. There were significantly more subjects with anxiety and depression (assessed by BAI and BDI scores) in the group with DSM-IV insomnia than in the group with insomnia symptoms, and more subjects with anxiety and depression in the group with insomnia symptoms than in the group of good sleepers. However, there was no significant variation in anxiety and depressions scores between PSG-I and PSG-NI. Two percent of PSG-NI and 2% of PSG-I subjects reported taking antidepressants on a regular basis (nonsignificant).

Results on snoring in our cohort have been published previously,[19] but these studies have not described any association with insomnia criteria. Both mild and severe OSA were less frequent in PSG-I (7% moderate and 11% severe OSA) than in those with PSG-NI (10% moderate and 5% severe OSA; $p < 0.001$). Logistic regression, indeed, demonstrated that OSA did not predict PSG-I; rather, the link between PSG-I and OSA was attributed to age.

Discussion

To our knowledge, this is the first epidemiologic survey of insomnia using PSG recordings in a representative sample of the population. The high prevalence of insomnia complaints across multiple countries is well recognized.[1–6] Insomnia is considered a major public health concern due to its potential interaction with mental and somatic diseases.[1,10,13,37–39] Insomnia is both a symptom and a promoter of disorders such as chronic pain, metabolic diseases, anxiety, depression, and suicide.[40–42]

It is internationally acknowledged that PSG is the gold standard for evaluating sleep structure, parameters, and quality.[7–36,43] On an individual level, PSG is expensive and may not be paid for by health authorities.[44] PSG is not used in epidemiological studies due to cost and difficulty recruiting subjects without a history of sleep complaints to participate in such a study.

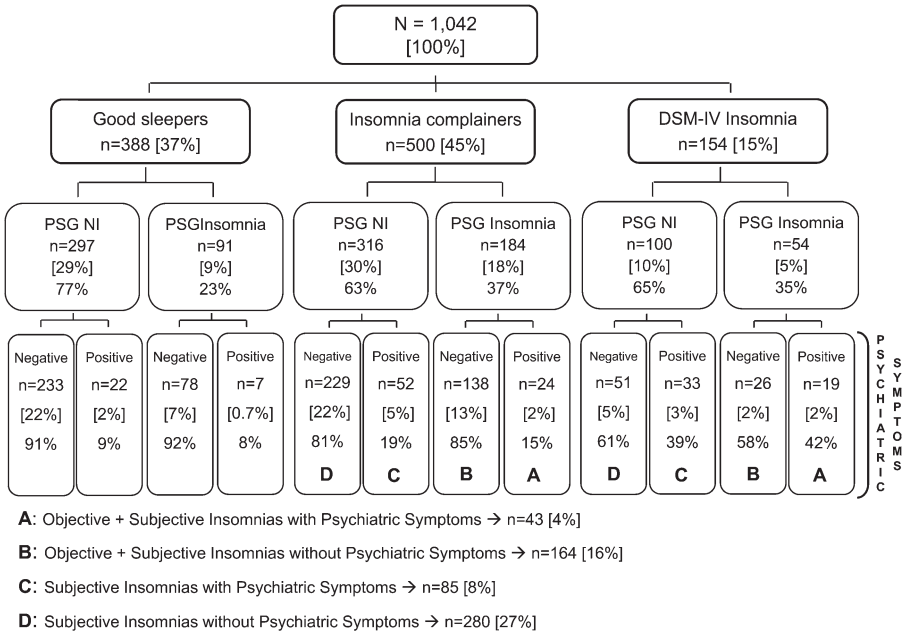

FIGURE 1: Hierarchical diagram of frequencies: subjective insomnia versus objective insomnia versus psychiatric symptoms. Percentages in brackets refer to total sample. Negative = scores on Beck Anxiety Inventory (BAI) and/or Beck Depression Inventory (BDI) < 20; Positive = BAI and/or BDI ≥ 20 (moderate-to-severe psychiatric symptomatology). Missing data: 130 participants are missing because they did not fulfill all BAI or BDI items. DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, 4th edition; NI = noninsomnia; PSG = polysomnography.

Surprisingly, we found an objective 32% PSG-I prevalence and a 27% prevalence of ACT-I, which is twice that of the prevalence of DSM-IV subjective insomnia (15%). The rate of DSM-IV insomnia was consistent with international estimates reported for insomnia.[1–6] For the first time, we report that a large proportion of subjects who did not complain of insomnia fulfilled PSG and ACT criteria for insomnia. We also found (see Table 4) that the PSG-I group had higher rates of disturbed sleep than the DSM-IV insomnia group, longer SOL (32.2 vs 18.5 minutes) and WASO (96.6 vs 55.1 minutes), and shorter TST (300.4 vs 342.0 minutes). An important concern is that some subjects with PSG-I may have no complaint of insomnia (23% of subjective good sleepers) or subjective insomnia symptoms (37%). However, only 35% of those with DSM-IV insomnia met criteria for PSG-I. Therefore, DSM-IV subjective criteria may not help predict diagnosis in shorter sleepers (PSG-I and ACT-I), the patients with more severe insomnia.

This discrepancy may be due to sociodemographics, but PSG-I patients had characteristics that are usually associated with subjective insomnia: they had higher BMI, were older, were more likely to be widowed, housewives, and retired or unemployed, and had lower socioeconomic status and lower levels of education than PSG-NI patients.[1–6] Therefore, it seems difficult to understand how sociodemographics could influence the selection of patients with severe insomnia. Comorbidities may also help explain the difference between PSG-I and DSM-IV insomnia rates. Other studies have identified OSA as a potential bias,[45] but the link between PSG-I and OSA was attributed to age.

Interestingly, psychiatric symptoms failed to predict PSG-I, which is difficult to explain due to the wide range of potential confounders modulating the association between psychiatric symptoms and sleep quality. Conversely, psychiatric symptoms increased significantly with the severity of subjective insomnia (see Table 1), affecting 8.2% of good sleepers, 18.3% of individuals with insomnia symptoms, and 37.6% of individuals with DSM-IV insomnia. Although short REM latency and high REM percentage are traditionally accepted as markers for depression, there is no consensus of PSG recommendations among patients suffering from both insomnia and psychiatric diseases.[7,43,46] However, in this same group of patients, PSG remains recommended when OSA or RLS are suspected.[47] In our study, PSG-I REM latency was longer and REM percentage smaller than in PSG-NI (see Table 3).

A final explanation could be the urban characteristic of São Paulo, which is among the largest metropolitan areas in the world. One of its most important characteristics is the disparity in wealth distribution, especially geographically, as a majority of the labor force lives in the city's periphery.[48] Sleep deprivation due to long

commutes and noisy environments may impact the perception of insomnia and its maintenance.[49] Another comorbidity found in the insomnia symptoms group and DSM-IV insomnia group was hypertension. Insomnia patients who sleep <6 hours per night are at significant risk of developing hypertension, which seems to be occurring in the São Paulo general population.[13]

Another major advantage when performing PSG and ACT in the general population is the opportunity to evaluate TST in insomnia individuals and controls. TST is crucial in understanding how insomnia may impact health. Evidence shows that insomnia is associated with comorbid somatic and psychiatric diseases[1,38,43,44,46]; however, it is unclear how insomnia negatively impacts health. One possible mechanism could be the reduction of TST. Many epidemiological studies have investigated the association between reduced TST and comorbidities such as obesity, type II diabetes, hypertension, and heart diseases.[12–14,50,51] In our study, we defined PSG-I with criteria that included TST and found that the PSG-I group had shorter TST than the PSG-NI group. In this urban sample, TST was especially low at around 300 minutes for PSG-I, compared to 364 minutes for PSG-NI, which is the common definition of short sleep.[12–14,50,51] Shorter sleep results from increased SOL and, above all, a raised WASO (96.6 minutes for PSG-I vs 34.3 minutes for PSG-NI; $p < 0.01$). Based on these results, we consider WASO to be the most significant PSG criteria to define insomnia.

This study also shows that the insomnia symptoms and DSM-IV insomnia groups had virtually the same objective sleep measures as the group of good sleepers. WASO, for example, was not significantly different in DSM-IV insomnia compared to good sleepers, and the arousal index was actually smaller in the DSM-IV insomnia group than in the good sleeper group. Although the same findings have been noted previously in non–population-based studies, our data confirm that insomnia in the general population is largely perceptual rather than objective, and that it is difficult to measure objective correlates of this important subjective experience.

We acknowledge that there may be potential limitations in our study. For instance, the evidence is based on a single night of PSG in the laboratory. The first PSG night is known to be disturbed often, and 2 nights are required for pharmaceutical trials.[43–46] When we compared the results obtained for TST and SE in PSG and ACT, we found a significant difference between the 2 techniques, with a longer TST and a better SE with ACT. However, we found no significant difference between TST and SE using PSG and ACT in the subgroup of individuals with insomnia, suggesting that the first night effect in PSG did not affect participants of our study.

We also recognize that, for some of our patients, demanding 8 hours in bed may deviate from their usual sleeping habits and may have increased their difficulty sleeping continuously; however, this protocol is commonly used in insomnia clinical trials, which recommend 8 hours in bed to avoid significant differences between subjects.[21]

As another potential limitation, our study focused on 1 city, São Paulo, Brazil, which may not be representative of other cities or countries, as its particular urban and demographic characteristics may partially explain some of the results.[48,49]

We also acknowledge that, despite interesting results, this study does not justify systematically performing PSG in subjects complaining of insomnia.

Lastly, the lack of reported daytime consequences does not imply better health status. Perhaps reported daytime consequences should be revised in future classifications of insomnia.

In conclusion, we performed the first epidemiological study on the prevalence of insomnia using objective PSG recordings in a representative sample of an urban population. This work demonstrates that the prevalence of objective insomnia based on PSG results was significantly higher than the subjective prevalence of insomnia based on DSM-IV questionnaires. However, psychiatric comorbidity segregated with subjective insomnia symptoms and DSM-IV criteria for chronic insomnia much more than with objective sleep findings. Future studies should aim to clarify why both subjects with good sleep and those reporting insomnia may have important sleep misperceptions.

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Potential Conflicts of Interest

Nothing to report.

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