

## Monthly Fluctuations of Insomnia Symptoms in a Population-Based Sample

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**Abstract**

*Study Objectives.* To document the monthly changes in sleep/insomnia status over a 12-month period; to determine the optimal time intervals to reliably capture new incident cases and recurrent episodes of insomnia and the likelihood of its persistence over time.

*Design.* Participants were 100 adults ( $M_{age} = 49.9$  years; 66% women) randomly selected from a larger population-based sample enrolled in a longitudinal study of the natural history of insomnia. They completed 12 monthly telephone interviews assessing insomnia, use of sleep aids, stressful life events, and physical and mental health problems in the previous month. A total of 1125 interviews out of a potential of 1200 were completed. Based on data collected at each assessment, participants were classified into one of three subgroups: good sleepers, insomnia symptoms, and insomnia syndrome.

*Results.* At baseline, 42 participants were classified as good sleepers, 34 met criteria for insomnia symptoms, and 24 for an insomnia syndrome. There were significant fluctuations of insomnia over time, with 66% of the participants changing sleep status at least once over the 12 monthly assessments (51.5% for good sleepers; 93.4% for insomnia symptoms, and 59.5% for insomnia syndrome). Changes of status were more frequent among individuals with insomnia symptoms at baseline ( $M = 3.55$ ,  $SD = 2.36$ ) than among those initially classified as good sleepers ( $M = 2.14$ ,  $SD = 2.70$ ). Among the subgroup with insomnia symptoms at baseline, 88.3% reported improved sleep (i.e., became good sleepers) at least once over the 12 monthly assessments compared to 27.7% whose sleep worsened (i.e., met criteria for an insomnia syndrome) during the same period. Among individuals classified as good sleepers at baseline, risks of developing insomnia symptoms and syndrome over the subsequent months were respectively 48.6%

and 14.5%. Monthly assessment over an interval of 6 months was found most reliable to estimate incidence rates while an interval of 3 months proved the most reliable for defining chronic insomnia.

*Conclusions.* Monthly assessment of insomnia and sleep patterns revealed significant variability over the course of a 12-month period. These findings highlight the importance for future epidemiological studies of conducting repeated assessment at shorter than the typical yearly interval in order to reliably capture the natural course of insomnia over time.

## Introduction

Insomnia is a prevalent public health problem associated with significant psychological (e.g., risks of depression), medical (e.g., risk of hypertension), and economic burden (e.g., absenteeism).<sup>1-3</sup> Cross-sectional studies have reported variable prevalence estimates of both insomnia syndrome (6%-13%) and insomnia symptoms (20%-60%).<sup>4-7</sup> Longitudinal studies have also produced variable incidence rates of new onset insomnia varying between 3% and 20% over intervals ranging from 1 to 7.5 years.<sup>8-14</sup> Other prospective studies have also reported highly variable persistence rates ranging from 20% to 69% for periods of 1 to 11 years<sup>13,15-17</sup> and remission rates ranging from 8% to 79%.<sup>11,15,18-22</sup>

Despite their contribution to improving the knowledge base about the epidemiology of insomnia, several methodological limitations make it difficult to synthesize results and draw meaningful comparisons across these studies. Among these are differences in the samples (e.g., clinical vs. general population), criteria for defining insomnia cases (e.g., symptoms vs. syndrome), varying follow-up intervals, as well as lack of distinguishing individuals with or without prior history of insomnia for incident cases. Typically, intervals between assessments are one year apart, but they can vary and range anywhere between 4 months<sup>19</sup> to as long as 20 years.<sup>4</sup> Most studies have used few time-points, often conducting a single follow-up after baseline assessment.<sup>9-10, 20, 23</sup> The few investigations that included more than two assessments<sup>4,12,15</sup> often used long intervals that ranged from 6 months<sup>12</sup> to 5 years<sup>4</sup> between any two assessments. With long intervals between assessments, it is not possible to determine whether insomnia actually persisted continuously or was interspersed with periods of remission.

Longitudinal studies with few time-point assessments often use different recall periods to evaluate the presence of sleep difficulties, periods that can vary between the past 2 weeks<sup>21</sup> to the past year.<sup>22</sup> Nevertheless, a majority of studies used the previous month as a reference period in order to minimize recall bias and to be consistent with diagnostic criteria for chronic insomnia in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR)*<sup>24</sup> and the *International Classification of Diseases, Tenth Revision (ICD-10)*.<sup>25</sup> Interestingly, there is no data showing that assessment of insomnia with reference to the past month accurately represents sleep patterns for the previous year. It is plausible that sleep patterns during that reference period may not be representative of the entire interval elapsed between baseline and follow-up assessments, particularly if intervals are far apart. No studies to date have prospectively documented the course of insomnia at a more microscopic level (i.e., with short intervals between assessments). Thus, it remains unclear to what extent insomnia represents a chronic and stable condition, as opposed to a waxing and waning condition that includes recurring and transient episodes. This information would be useful to better characterize the natural course of insomnia, document burden of illness, and determine the most appropriate time to intervene.

The objective of the present study was to document the monthly fluctuations of sleep patterns and insomnia over a one-year period in a population-based sample. We were interested in examining what is the optimal time window or interval in the context of epidemiological research to reliably capture new incident cases of insomnia and recurrent episodes of insomnia and to make a reliable prediction about its persistence over time

## Method

### Study Context and Participants

Data from this study are derived from a larger epidemiological study conducted in Canada. The study began with a population-based telephone survey to document the prevalence of insomnia and determinants of treatment-seeking behaviors.<sup>5, 26</sup> Sample selection involved random-digit dialing and use of Kish method.<sup>27</sup> At the end of the telephone interview, respondents were invited to participate in the longitudinal phase of the study, which involved completion of several postal evaluations over five years. The objective of this longitudinal arm of the study was to describe the natural course of insomnia (e.g., incidence, persistence, remission rates) and identify risk factors associated with insomnia. The study also involved completion of 12 monthly telephone interviews over a one year period (i.e., from October 2008 to October 2009) for a subsample of 100 individuals randomly selected among the French-speaking participants of the province of Québec. The present study reports the results obtained from this subsample.

Of the 10,002 participants who completed the initial telephone survey, 3,067 took part in the longitudinal arm of the study, including 1,921 French-speaking residents of the province of Québec. Among that subgroup, 115 individuals were randomly selected and solicited by telephone to participate in this sub-study and complete 12 monthly interviews. Six of them declined to participate and nine were excluded after repeated attempts to reach them, yielding a final sample of 100 participants. Participants received a compensation of \$100 for completing the 12 interviews.

### Classification of Participants

After each of the 12 monthly assessments, participants were classified into one of three subgroups. Consistent with our previous studies,<sup>12, 15</sup> sleep status was defined by an algorithm using a combination of insomnia diagnostic criteria from the DSM-IV-TR<sup>24</sup> and the ICD-10<sup>25</sup>, and the use of sleep-promoting medication. The data used to classify participants were derived from the *Insomnia Severity Index*<sup>28-29</sup> and *Pittsburgh Sleep Quality Index*<sup>30</sup> (described in the next section).

*Insomnia syndrome.* Participants classified in this group met all diagnostic criteria for insomnia. They were dissatisfied (score of 3 or 4 on a 0-4 scale) with their sleep patterns and had symptoms of initial, middle, or late insomnia at least three nights per week. Initial insomnia was defined by sleep onset latency greater than 30 minutes, middle insomnia was defined by a period of wakefulness after sleep onset lasting more than 30 minutes, and late insomnia was defined by a final awakening occurring more than 30 minutes before the desired wake time. Participants also reported significant distress or daytime impairments related to sleep difficulties (score of 3 or 4 on a scale of 0-4). The one month duration criterion was not used to classify participants in this subgroup because the assessments were repeated monthly. Lastly, participants were automatically categorized as having an insomnia syndrome if they used prescribed sleep promoting medication three nights or more per week for at least the past month.

*Insomnia symptoms.* Participants classified in the insomnia symptoms subgroup reported initial, middle, or late insomnia at least three nights per week without fulfilling all diagnostic criteria for an insomnia syndrome (i.e., they reported being satisfied with their sleep or reported no or minimal distress or daytime consequences). Also included in

this group were participants dissatisfied with their sleep but without symptoms of initial, middle, or late insomnia. Participants using prescribed medications fewer than three nights per week or over-the-counter (OTC) medications for sleep at least one night per week were also classified in this group.

*Good sleepers.* Participants in this subgroup were satisfied with their sleep (i.e., score of 0-2 on a scale of 0-4), did not report symptoms of insomnia, and did not use prescribed or OTC medication to promote sleep.

#### Telephone Interview

Telephone interviews were conducted by five trained and supervised undergraduate psychology students. Most participants had the same interviewer for the 12 interviews. The first interview started with a brief description of the study objective and, after obtaining verbal consent, the interviewer proceeded with questions on sleep and insomnia symptoms, utilisation of sleep promoting products, occurrence of stressful life events, and physical and mental health problems over the previous month. The 12 interviews were identical and the average interview duration was 10 minutes.

*Sleep/Insomnia.* The first part of the interview covered sleep difficulties in the preceding month, including the type, the severity, the duration, and the impact of insomnia symptoms. Standard questions from the Insomnia Severity Index (ISI) were asked.<sup>28-29</sup> Participants rated the severity of their difficulty falling asleep, staying asleep or waking up too early on a 5-point scale from “0” (no difficulty) to “4” (very severe difficulty). These questions were followed by estimates of weekly frequency of (a) sleep onset latency exceeding 30 minutes, (b) time awake after sleep onset greater than 30 minutes, (c) final morning awakening occurring at least 30 minutes before the planned



time, and (d) total sleep time of less than 6 hours. Participants rated their sleep quality on a 4-point scale from “0” (very refreshing) to “3” (not refreshing) and the weekly frequency of experiencing non-refreshing sleep. Sleep satisfaction was evaluated using a 5-point scale from “0” (very satisfied) to “4” (very dissatisfied). Finally, participants “dissatisfied” or “very dissatisfied” with their sleep and or those confirming sleep problems (yes/no), reported the frequency, the duration, the consequences (i.e., impairment of daytime functioning, occupational or social activities, fatigue, mood disturbance), the noticeability to others, and the level of concern about their sleep problems using a 5-point rating scale from “0” (not at all) to “4” (very much).

*Products used for sleep problems.* Participants were asked if they had used prescription medications, OTC medication, natural products, and alcohol to promote sleep in the preceding month. If participants confirmed using any of these products, they were then asked to estimate the weekly use of these products.

*Depressive symptoms.* To investigate the presence and severity of depressive symptoms, two questions drawn from the Patient Health Questionnaire-9 (PHQ-9)<sup>31</sup> were administered. Participants estimated how often they had been bothered by (1) little interest or pleasure in doing things and (2) feeling down, depressed, or hopeless over the last 2 weeks on a 4-point scale from “0” (not at all) to “3” (almost every day). The mean score of these two questions were used to quantify the severity of depressive symptoms.

*Anxiety symptoms.* Participants estimated how often over the last 2 weeks (1) they had felt nervous, anxious or on edge and (2) whether they had difficulty controlling their worries on a 4-point scale from “0” (not at all) to “3” (almost every day). The mean score of those two items was used to quantify the severity of anxiety symptoms.

## Data Analysis

Data manipulation and analyses were completed using SAS 9.3. Data distributions were checked for normality and outliers. Missing values were not imputed. Number of sleep status changes was computed for each participant and group comparisons between subgroups at baseline were examined using a one-way ANOVA and post-hoc comparisons were computed using Bonferroni alpha corrections. All hypothesis testing was based on an alpha level of two-tailed 5%.

Conditional probabilities were computed to estimate (1) the probability of a participant changing their sleep status anytime over the 12 monthly assessments relative to their baseline status and (2) the probability of a participant having insomnia at a given month to report insomnia again after 1 to 6 months, in order to establish the minimal duration for insomnia to become “chronic” (i.e., having a 100% probability to report insomnia in the next month).

To examine the extent to which a single annual assessment might have underestimated sleep changes, two series of computations were completed. First, rates of sleep changes comparing baseline (T1) and one-year follow-up (T12) were computed, as usually done in most epidemiological studies. These rates represent our comparison point. Second, cumulative rates of sleep changes were also computed over various time intervals, such as 1, 3, 6, 9 and 12 months. Four sleep changes (or sleep trajectories) were documented : (1) incidence of new cases of insomnia symptoms/syndrome for those who were good sleepers at baseline (i.e., a change from good sleeper status at baseline to a symptoms or syndrome status at any future time point, which varied as a function of the time interval being studied), (2) incidence and recurrence of insomnia symptoms/

syndrome episodes (i.e., a change from good sleeper status at any given time point to a symptoms or syndrome status at a future time point), (3) persistence of insomnia symptoms/syndrome (e.g., no change in symptoms or syndrome status from one assessment at any time point to a future time point), and (4) remission of insomnia (i.e., a change from symptoms or syndrome status at any time point to good sleeper status at a future time point). Marginal means and standard errors for incidence, persistence, and remission rates were computed using logistic generalized estimating equations (GEE, using SAS GENMOD procedure). GEE models were preferred for their capacity to control for random (participant) variance (since the same participant may be included in a specific analysis depending of the availability of multiple occasions of sleep changes), their robustness to variance-covariance misspecification, and their emphasis on producing marginal (population based) means instead of conditional (subject-based) means.

All analyses were weighted according to a normalized weight derived from the joint distribution of gender, age group (18 to 49 yrs, 50 yrs and over), and sleep status. The joint distributions in the sample ( $N = 100$ ) and in the larger study ( $N = 3067$ ) were compared to compute sampling weights.

## **Results**

### **Sample**

Participants were 100 adults (66% women) between 23 and 85 years of age, ( $M = 49.9$ ;  $SD = 13.9$ ). A majority of the participants completed at least a high-school degree (82%), was married or living with a partner (64%), working full-time (50%), and had a day work schedule (63%) (see Table 1). At baseline, 42 participants were classified as

good sleepers, 34 presented insomnia symptoms, and 24 presented an insomnia syndrome.

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Insert Table 1 about here

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Of the projected 1200 interviews (i.e., 100 participants X 12 interviews), 1125 (93.7%) were completed as planned, resulting in 1121 classifiable sleep status. The average number of interviews completed per participant was 11.2 (SD = 1.3, range = 5 to 12), with 54 participants completing all 12 interviews. Participants with one or more missing interviews were not significantly different from those who completed all interviews on gender, marital status, income, or sleep status at baseline. However, they were significantly younger than participants who completed all interviews ( $M = 46$  vs. 53 years old),  $t(98) = 2.71, p = .008$ .

Based on the weighted data, 42.9% of the sample ( $N = 100$ ) met criteria for insomnia symptoms at least one month during the study (but never met criteria for an insomnia syndrome), 9.0% met criteria for an insomnia syndrome at least once (but never for insomnia symptoms), 26.7% reported insomnia symptoms and syndrome on at least one occasion during the study, and 21.4% never reported any insomnia symptoms or syndrome during the 12 assessments.

#### Changes of sleep status over time

Of the total sample, 66% changed sleep status at least once over the 12 monthly assessments, leaving 34% who exhibited a stable sleep status over that same period. A change of status was most common among those who presented insomnia symptoms at baseline (31/34; weighted % = 93.4%), followed by those with an insomnia syndrome

(14/24; weighted % = 59.5%), and good sleepers (21/42; weighted % = 51.5%) (see Table 2). Thus, sleep was more stable among good sleepers and participants with insomnia syndrome than among participants with insomnia symptoms,  $X(2, N=100) = 17.15, p < .001$ . Adjusting for the variable number of interviews per participant, participants changed sleep status an average of 2.73 times over the 12 monthly assessments. Participants with insomnia symptoms at baseline changed sleep status significantly more frequently ( $M_{weighted} = 3.46$ ) than good sleepers ( $M_{weighted} = 2.12$ ),  $F(2, 97) = 3.05, p = .05$ , while participants with an insomnia syndrome ( $M_{weighted} = 2.76$ ) did not differ significantly from either good sleepers or participants with insomnia symptoms.

Table 2 presents data on the proportion of participants with at least one change to a different sleep status relative to their baseline status and the direction of the change (i.e., worsened or improved) during the course of the year. Among good sleepers at baseline, 48.6% (weighted %) subsequently developed insomnia symptoms and 14.5% developed an insomnia syndrome at least once over the year. Among participants with insomnia symptoms at baseline, 88.3% experienced improved sleep (i.e., became good sleepers) and 27.7% reported worsening of sleep (i.e., met criteria for an insomnia syndrome) at least once over the year. By comparison, 59.5% of the participants with insomnia syndrome at baseline partially improved their sleep (i.e., insomnia symptoms) and 26.3% experienced a complete remission (i.e., became good sleepers) at least once over the year.

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Insert Table 2 about here

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Conditional probabilities were computed to determine the minimum duration an insomnia syndrome should persist before it could be defined as a chronic condition. Specifically, the probability to continue meeting criteria for an insomnia syndrome after 1, 2, 3, 4, 5 or 6 consecutive months was computed (see Figure 1). Since the distribution of probabilities was non-normal (i.e., skewness and kurtosis over 2), the *median* conditional probability is reported instead of the arithmetic mean. After an initial diagnosis of insomnia syndrome, the median probability to report the same diagnosis in the following month [i.e., the conditional probability  $p(\text{sy} | \text{sy})$ ], was 50% on average. After two consecutive months with an insomnia syndrome, the probability to meet criteria for insomnia syndrome at the third month [i.e.,  $p(\text{sy sy} | \text{sy})$ ], increased to 87.5%. The median probabilities after 3, 4, 5 or 6 consecutive months with insomnia diagnoses were all 100%.

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Insert Figure 1 about here

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A series of *GEE* analyses (similar to logistic regressions for dependant observations) were conducted to estimate the magnitude of the differences in incidence, persistence, and remission rates between the commonly used “baseline and 12-month follow-up” method compared to various (smaller) time intervals. First, weighted cumulative rates for incidence of new cases, incidence and recurrence of insomnia episodes, persistence of insomnia episodes, and remission of insomnia episodes were examined as a function of time intervals that ranged from 1, 3, 6, 9 and 12 months (see Figures 2-5). Second, incidence, persistence, and remission rates at each time point (i.e., 1, 3, 6, and 9 months) were compared to the rates obtained for the commonly used

“yearly” interval (comparing baseline, i.e., month 1 vs. month 12 sleep status). For these analyses, caution is warranted for the 12-month interval data, as there were substantially fewer observations available to describe these trajectories (i.e., incidence rates at 1 month were based on about 500 observations, while only 21 observations were available for incidence estimates at 12 months).

Weighted cumulative incidence rates (Figure 2) of new cases of insomnia symptoms (computed from participants categorized as good sleepers at baseline) were 11.4% after 1 month, 35.6% after 3 months, and it increased linearly to 48.6% after 12 months. For insomnia syndrome, weighted cumulative incidence rates were 3.5% at a 1-month interval, 9.1% at 3-month, and 14.5% at 6-, 9- and 12-month intervals; no new case of insomnia syndrome emerged between 6- and 12-months follow ups. When sleep status was compared only between baseline and 12-month follow-up, weighted incidence rates for new cases of insomnia symptoms (i.e., good sleepers at baseline and insomnia symptoms at 12 months) were much lower (3.8%) than cumulative estimates and no new case of insomnia syndrome was observed.

Weighted cumulative incidence/recurrence cases (Figure 3) of episodes of insomnia symptoms (computed from participants categorized as good sleepers at one-time point) were 18.2% after 1 month, 30.0%<sup>1</sup> after 3months, with continued increases up to 57.1% after 12 months. For episodes of insomnia syndrome, weighted cumulative

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<sup>1</sup> To illustrate computation of these estimates, the 30% was based on a total of 176 data points derived from 69 participants with data available for that many 3-month intervals. Those 176 intervals are non-overlapping (each referring to distinct assessments; for example, month 1 to 4 for the first interval, month 4 to 7 for the second interval, etc.) and they included at least one occasion where the participant met criteria for a good sleep status and this status was not terminal (i.e., it was not the final status of the interval). 30% of these 176 observations involved a monthly change from good sleep to insomnia symptoms, which could be a first new episode or a recurrence of an insomnia episode.

incidence rates were 3.3% at a 1-month interval, 5.9% at a 3-month interval, and it reached a plateau at 10.6% after 6 months and 11.9% after 12 months. When sleep status were compared between baseline and 12-month follow-up, weighted incidence rates for a new or recurrent episode of insomnia symptoms were much lower (3.8%) than cumulative rates and no new case of insomnia syndrome was observed at that time.

Among participants with insomnia symptoms at any time-point, weighted persistence rates (Figure 4) were 48.6% after 1 month, 57.4% after 3 months, and it increased to 63.4% and 62.8% after 9 and 12 months respectively. Among those with an insomnia syndrome at any time point, persistence rates were 47.0% after 1 month, 56.7% after 3 months and it increased to 59.1% and 58.4% after 9 and 12 months, respectively. Comparisons of sleep status derived from baseline and 12-month follow-up assessment only yielded weighted persistence rates (i.e., insomnia at baseline and at 12-month follow up) that were in the same range (according to standard errors) for both symptoms (53.1%) and syndrome (65.4%) as those derived from the other method.

Rates of remission episodes (Figure 5) among participants with insomnia symptoms at any time point were 37.4% after 1 month, and it increased linearly from 55.2% after 3 months to 81.3% after 12 months. Thus, after 12 months, 81.3% of the participants who had insomnia symptoms at any assessment point were in remission (became good sleepers) at least once during that same interval. Among participants with an insomnia syndrome at any time point, remission rates were 13.4% after 1 month, 14.2% after 3 month and it increased to 27.2% after 12 months. When sleep status was compared between baseline and 12-month follow-up only, weighted remissions rates (i.e., insomnia at baseline and good sleepers at 12-month follow up) were much lower for both



symptoms (38.5%, similar to 1-month remission rates according to standard errors) and syndrome (13.3%, similar to 1-, 3- and 6-month remission rates according to standard errors) than rates derived from the other method.

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Insert Figures 2 to 5 about here

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### **Discussion**

The main findings of this study indicate that there are frequent changes in the sleep/insomnia status of a community-based sample over a 12-month period. The variability is particularly pronounced among individuals with insomnia (both symptoms and syndrome) at baseline, whereas good sleepers showed a more stable course of their sleep status. These results underscore the importance for prospective epidemiological studies to conduct repeated assessments at shorter than the typical yearly interval in order to reliably capture the natural course of insomnia over time.

Although the epidemiology of insomnia has received considerable attention in the last decade, few studies have used a prospective design with more than two repeated assessments. This longitudinal study is unique in its microscopic investigation of insomnia with the use of 12 repeated assessments at monthly intervals. Compared to studies that used only two assessments and longer intervals between assessments,<sup>14, 16, 22</sup> the present study yielded higher estimates of incident cases for both symptoms (49%) and syndromes (15%). Conversely, rates of persistent insomnia over several consecutive monthly intervals were lower than previously reported in studies using fewer assessment points.<sup>9-10, 20</sup> Although it may be no surprise that repeated, monthly assessments capture

more new cases relative to a yearly assessment with the “last month” as reference period, this finding raises several important questions. How many consecutive monthly assessments are needed to reliably capture true incident cases of chronic insomnia? What is the most “cost efficient time window” to provide reliable estimate of incidence, persistence, and remission? How long should insomnia persist to be considered chronic?

Based on our results, the largest number of new insomnia cases (35.6% for symptoms and 9.1% for syndrome) emerged during the first three months of the study; an additional 10% developed symptoms at the 9- and 12-month follow ups but there was no new case of insomnia syndrome after the 6-month assessment. Data derived from the 9- and 12-month intervals should be interpreted cautiously given the smaller number of observations available for these longer intervals. Overall, these findings suggest that repeated, monthly assessments over 3- (to capture symptoms) or 6-month intervals (to capture a full syndrome) with a recall period of one month might provide the most accurate data about incidence rates while also being most cost-effective in terms of human resources needed and burden on participants.

The results about the minimum duration required to determine chronicity of insomnia are quite informative and consistent with recent changes in DSM5 diagnostic criteria to define a chronic insomnia disorder.<sup>32</sup> The present data showed that the presence of an insomnia syndrome for one month is not a reliable indicator of chronic insomnia given that there is a 50% probability that a participant will not meet criteria for an insomnia syndrome the following month. However, when the condition is present for three consecutive months, there is a 100% probability that the condition will persist at the

next monthly assessment. Thus, the present findings provide evidence supporting the recent DSM5 increase from one to three months to define chronic insomnia.

With regard to time course and prognosis, results of the insomnia symptoms subgroup are of particular interest given their more variable course over time. Only 6.6% of this subgroup remained stable for all 12 assessments, suggesting that reports of insomnia symptoms may often be a fairly transient condition. While the majority of these individuals tended to remit rather than worsen over time, the subgroup of individuals (27.7%) who worsened from symptoms to a full insomnia syndrome is of particular interest given their poorer prognosis. Additional information to better characterize this subgroup of individuals at risk for persistent insomnia would be helpful to guide early interventions or even prevention programs at the population level.

There are several limitations that must be kept in mind when interpreting the present findings. First, a sample size of 100 is quite small to make reliable estimates about incidence and persistence of insomnia. In addition, it is plausible that conducting monthly assessments of sleep/insomnia status may produce some reactivity to the measurement process and alter the way an individual perceives his sleep and respond to a survey. Also, while a monthly recall period seemed reasonable for the purpose of the present study, the optimal recall period is likely to vary as a function of the specific purpose of assessment. For instance, the use of daily sleep diaries over a 2-week period is the recommended standard for assessing outcome in insomnia trials<sup>33</sup>, but it could be that a shorter or longer recall period would be more appropriate for longitudinal studies and perhaps even preferable to a 1-month recall period as in the present study. One way to check on the most appropriate interval for a study as this one would have been to ask

participants to estimate their sleep/insomnia retrospectively for the previous 3, 6, or even 12 months, in addition to their monthly recalls. By asking for two ratings (one for the previous month and one for the longer period elapsed until that assessment), this would have allowed for testing accuracy of sleep/insomnia ratings across different reporting periods and directly check for memory and recall bias<sup>34</sup>. Finally, the analyses of this paper are fairly descriptive and additional analyses with a larger sample could yield some very useful information about trajectory of changes and several moderating variables (e.g., life events, stress, change of health status, treatment initiation) that could potentially alter the course of insomnia over time. Such analyses could identify potentially modifiable behaviors that confer risk to the incidence and maintenance of insomnia.<sup>35-37</sup>

Additional prospective studies with repeated assessments would be helpful to achieve a better understanding of the natural history of insomnia and factors moderating its trajectories over time. Such longitudinal studies should also use standard definitions of insomnia cases, separating symptoms from syndromes, and use operational criteria to assess frequency, intensity, and duration of insomnia complaints. It is only by standardizing these methodological features that we can move the field forward and improve our understanding of the true prevalence, course, and morbidity of insomnia.

Table 1.

*Description of the sample at baseline*

	Total Sample (N=100)		Good Sleepers (n=42)		Insomnia Symptoms (n=34)		Insomnia Syndrome (n=24)		<i>F</i> ( $\chi^2$ )
	<i>M</i> ( <i>n</i> )	<i>SD</i> (%)	<i>M</i> ( <i>n</i> )	<i>SD</i> (%)	<i>M</i> ( <i>n</i> )	<i>SD</i> (%)	<i>M</i> ( <i>n</i> )	<i>SD</i> (%)	
Gender									
Women	(66)	(66.0)	(29)	(69.0)	(22)	64.7	(15)	(62.5)	(0.33)
Age	50.0	13.9	49.81	15.0	47.7	12.9	53.5	13.2	1.22
Depression Symptoms (0-3)	0.51	0.71	0.20 <sub>a</sub>	0.33	0.50 <sub>a</sub>	0.74	1.08 <sub>b</sub>	0.83	14.99*
Anxiety Symptoms (0-3)	0.76	0.81	0.56 <sub>a</sub>	0.66	0.56 <sub>a</sub>	0.57	1.40 <sub>b</sub>	1.01	11.91*

\*  $p < .05$ *Note.* Means on the same row with different subscripts (a,b) are significantly different.

Table 2.

*Proportion of participants (weighted data) with at least one change toward a different sleep status according to baseline sleep status.*

New Status	Baseline Status					
	Good Sleepers (n=42)		Insomnia Symptoms (n=34)		Insomnia Syndrome (n=24)	
	%	<i>n</i>	%	<i>n</i>	%	<i>N</i>
Good Sleepers			88.3	29	26.3	6
Insomnia Symptoms	48.6	20			59.5	14
Insomnia Syndrome	14.5	7	27.7	10		
Any change	51.5	21	93.4	31	59.5	14

*Note:* Column percentages summed over the total (any change) since new sleep status categories are not mutually exclusive (i.e., an individual could have changed toward two different sleep status over the year).

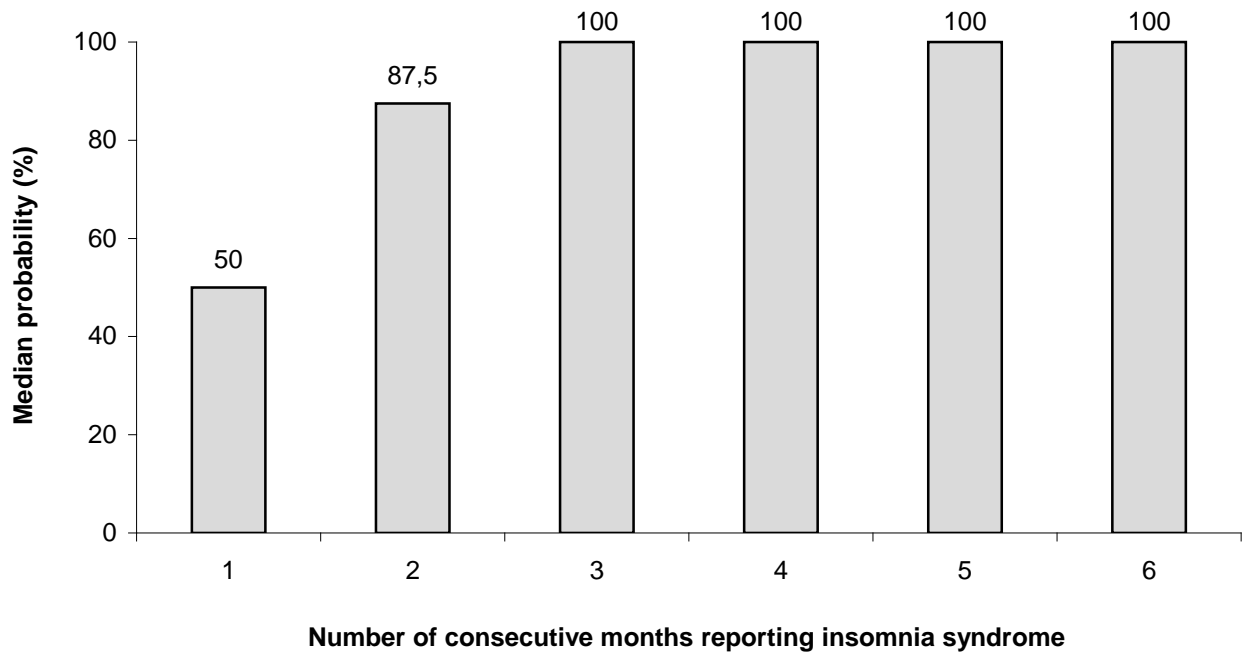


Figure 1. *Median conditional probabilities to report insomnia syndrome based on the number of consecutive months with the diagnosis*

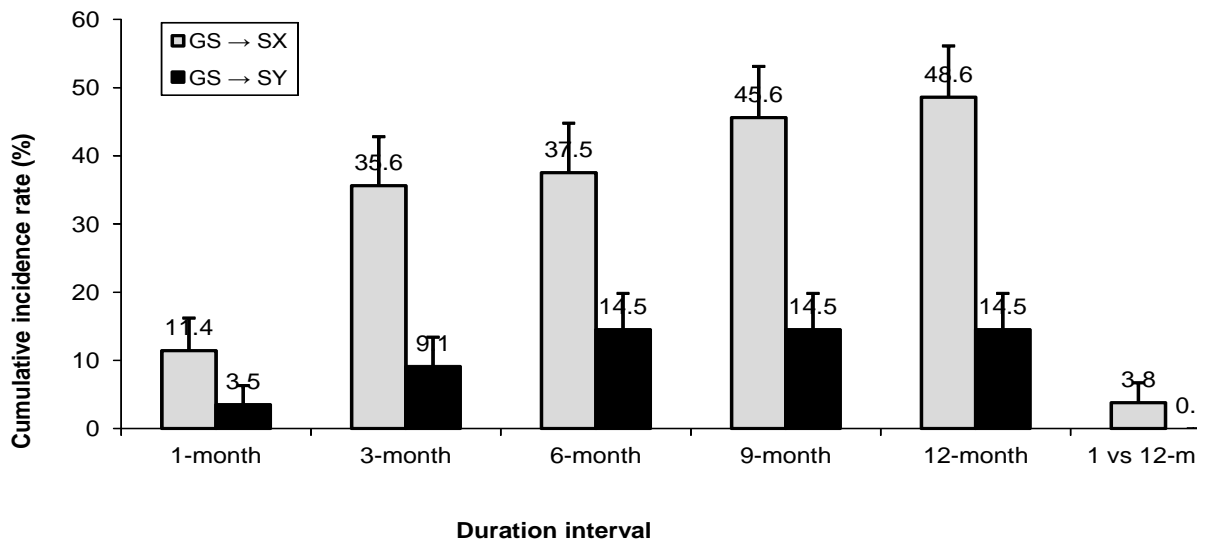


Figure 2. Cumulative incidence rates of new cases of insomnia symptoms or syndrome (weighted mean  $\pm$  standard error) according to various duration intervals and a monthly sampling frequency. The last column computes the weighted incidence rate based on a yearly sampling frequency (comparing 1- vs. 12-month sleep to identify incidence cases). All numbers are based on  $N = 42$  good sleepers at T1 but the 1 vs. 12-month estimate was based on 34 participants (i.e., those who completed the interview at both 1- and 12-month assessments).



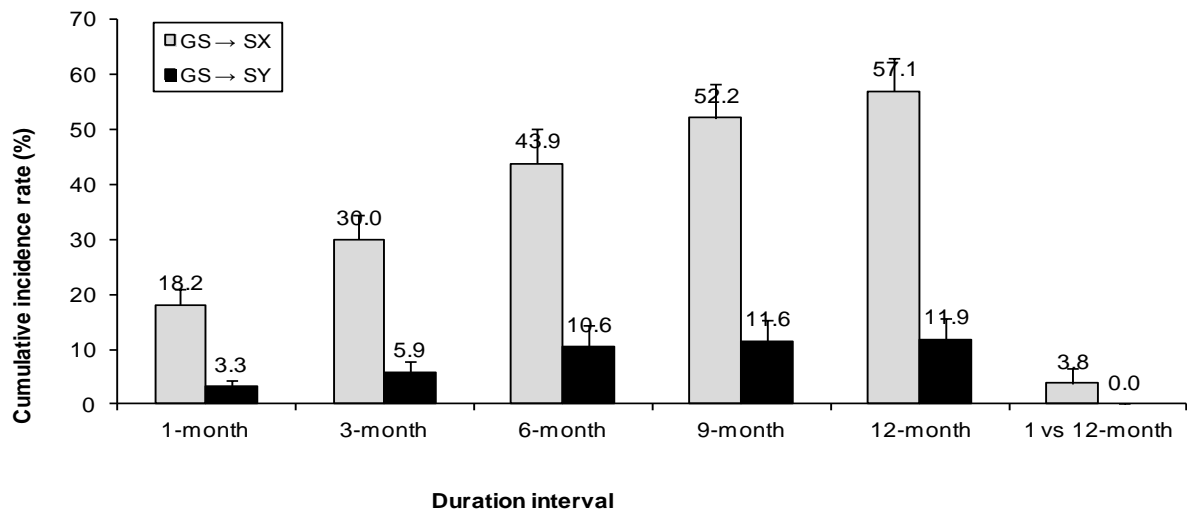


Figure 3. *Cumulative incidence rates of episodes (new or recurrence) of insomnia symptoms or syndrome (weighted mean  $\pm$  standard error) according to various duration intervals and a monthly sampling frequency. The last column computes the weighted episode incidence rate based on a yearly sampling frequency (comparing 1- vs. 12-month sleep to identify incidence cases – which are by default all new cases).*

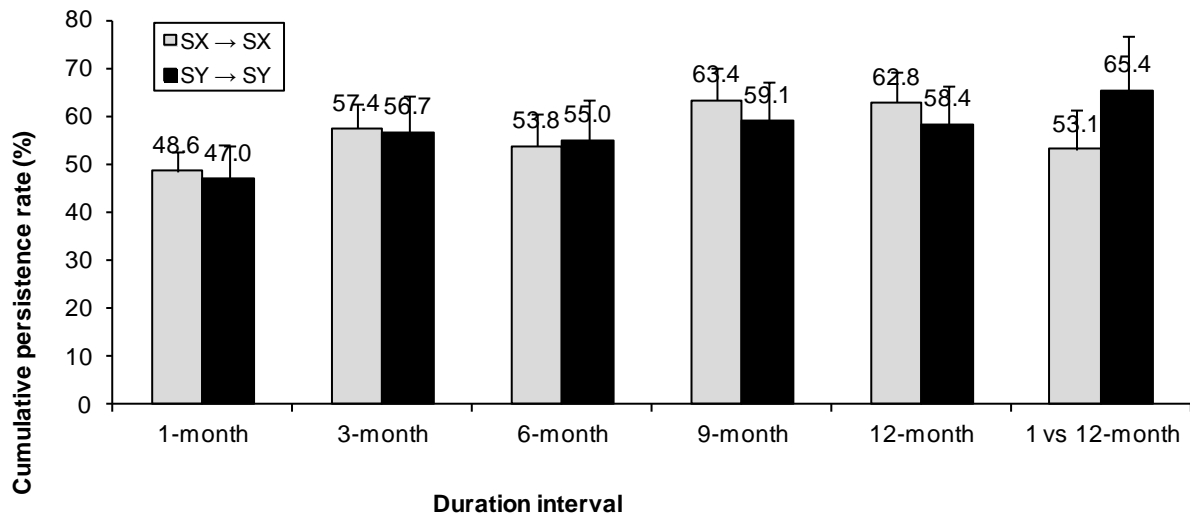


Figure 4. Cumulative persistence rates of episodes of insomnia symptoms or syndrome (weighted mean  $\pm$  standard error) according to various duration intervals and a monthly sampling frequency. The last column computes the weighted persistence rate based on a yearly sampling frequency (comparing 1- vs. 12-month sleep to identify persistent cases).

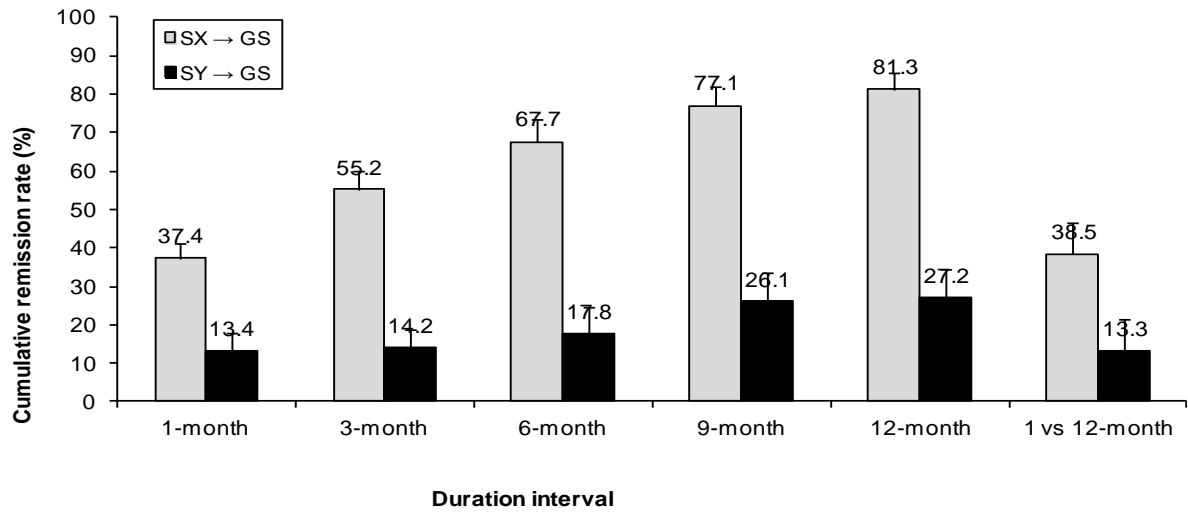


Figure 5. *Cumulative remission rates of episodes of insomnia symptoms or syndrome (weighted mean  $\pm$  standard error) according to various duration intervals and a monthly sampling frequency. The last column computes the weighted remission rate based on a yearly sampling frequency (comparing 1- vs. 12-month sleep to identify remission cases).*

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