Sleep Medicine 15 (2014) 180–186

Contents lists available at ScienceDirect

Sleep Medicine

journal homepage: www.elsevier.com/locate/sleep

Original Article

Who is at risk for having persistent insomnia symptoms? A longitudinal study in the general population in Korea ☆

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ARTICLE INFO

Article history:
Received 14 June 2013
Received in revised form 26 August 2013
Accepted 4 September 2013
Available online 24 December 2013

Keywords:
Insomnia
Epidemiology
Mental health
Quality of life
Longitudinal
Sleep

ABSTRACT

Objectives: Our study had three goals: (1) to investigate the longitudinal course of insomnia symptoms over 4 years (3 time points) by analyzing the trajectory of insomnia symptoms for all participants, (2) to compare persistent insomnia symptom to nonpersistent insomnia symptom groups on mental health and quality of life (QoL), and (3) to conduct exploratory analyses on the relative contribution of multiple factors to persistence of insomnia symptoms.
Methods: Our population-based longitudinal study utilized a community-based sample from the Korean Genome and Epidemiology study (KoGES). Participants were 1247 individuals (40.1% men; mean age, 54.3 ± 7.1 years). Insomnia, QoL (measured by 12-item Short-Form health survey [SF-12]), sleep-interfering behaviors, and depression (measured by the Beck Depression Inventory [BDI]) were followed with biennial examinations at 3 data points spaced 2 years apart (baseline, time 1, and time 2).
Results: Among individuals experiencing insomnia symptoms at baseline, the most common trajectory was to experience persistent nocturnal insomnia symptoms across all 3 time points. Those with persistent insomnia symptoms had significantly lower physical and mental QoL (measured by SF-12) and higher depression (measured by BDI) at time points compared to those without persistent nocturnal insomnia symptoms. A follow-up exploratory receiver operating characteristic curve (ROC) analysis identified poor sleep quality, frequent sleep-interfering behaviors, and low mental health QoL as the strongest predictors of persistent insomnia symptoms above other well-known risk factors.
Conclusions: In particular, an interaction between poor sleep quality, sleep-interfering behaviors, and mental health QoL appeared to be the strongest risk factor for persistent insomnia symptoms.
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1. Introduction

Epidemiology studies have consistently characterized poor sleep and insomnia as highly persistent. Estimated rates of persistence range between 28.2% and 74% [1–7]. The wide range of prevalence estimates is most likely related to the use of various definitions of poor sleep, insomnia, and persistence. To facilitate the synthesis of the literature, we use the term *insomnia syndrome,* when referring to individuals who report one or more nocturnal symptoms at least 3 nights per week for at least one month along with associated daytime impairment or distress, and the term *insomnia symptoms* (often also called poor sleep or sleep disturbance in other studies) in reference to the presence of nocturnal symptoms at least three nights per week which may or may not be associated with distress or daytime consequences [3,8]. The focus of our paper is on *persistent insomnia*, which we defined as the presence of insomnia syndrome or symptoms at 3 consecutive time points in our study [9].

Spielman and Glovinsky [10] proposed the 3P model, which identifies predisposing, precipitating, and perpetuating factors that

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http://dx.doi.org/10.1016/j.sleep.2013.09.024

together provide a conceptual framework for the development and maintenance of insomnia syndrome. Consistent with this framework, previous longitudinal studies [2,5,6] have found that poor mental health (e.g., higher levels of depression, anxiety, and overall mental health), personality factors (e.g., lower extraversion, higher levels of arousability), behavioral factors (e.g., larger caffeine intake), demographic factors (e.g., female gender, age, unemployment, nonwhite race), poor physical health (e.g., higher levels of bodily pain, poorer general health), and daytime symptoms of insomnia at baseline constitute vulnerabilities for incidence of insomnia syndrome. In contrast, obesity, alcohol intake, and physical health, as well as polysomnography estimates of short sleep duration and sleep apnea were not associated with incidence of persistent insomnia syndrome [5]. Studies that focused on risks for the persistence of insomnia symptoms, with or without associated distress or impairment, found that similar factors constitute a risk for persistence of insomnia symptoms over time. For example, 2 population-based studies of the Penn State cohort identified mental health problems, higher levels of psychologic distress, poor physical health, female gender, age younger than 40 years, family history of sleep problems, and short objective sleep duration were risks for persistence of insomnia symptoms over a 7.5-year period [5,8].

To the best of our knowledge, there have been no published studies examining the potential contribution and importance of behavioral risk factors in comparison to other well-known risk factors in predicting the persistence of insomnia symptoms. Our study had 3 goals: (1) to investigate the longitudinal course of insomnia symptoms over 4 years (3 time points) by analyzing the trajectory of insomnia symptoms in a large sample, (2) to compare individuals with persistent insomnia symptoms to those with nonpersistent insomnia symptoms on mental health and quality of life (QoL), and (3) to conduct exploratory analyses on the relative contribution of multiple factors to persistence of insomnia symptoms.

Utilizing longitudinal (4 years) data collected from an ongoing population-based study in Korea, we identified insomnia symptom trajectories. Next we conducted analyses to investigate the correlates of the persistent insomnia symptoms trajectory. Finally, we conducted receiver operating characteristic curve (ROC) analysis to evaluate potential predictors of persistent insomnia symptoms. ROC is a data-driven nonparametric statistical technique that identifies the predictor variables and associated cutoff points that best discriminate individuals as either achieving or not achieving a given dichotomous outcome [11]. We explored a large set of potential predictors of persistent insomnia symptoms, including demographic variables, health behaviors, health status (presence of diabetes mellitus [DM], hypertension, and general perceived health), depression, sleep behaviors, sleep quality, and history of psychiatric illness.

2. Materials and methods

2.1. Study design and sample

Participants of our study were part of a larger study, namely the Korean Genome and Epidemiology Study (KoGES), which is an ongoing population-based cohort study that started in 2001 under the original title of the Korean Health and Genome Study. Detailed information on the study design and aims of the KoGES have been previously reported [12]. Our study used a subset of individuals from the original cohort members recruited from Ansan, South Korea, and we used measures that were introduced to the study in 2007 (baseline) when data essential to the aims of our study were collected. Participants were followed with biennial examinations at 3 data points spaced 2 years apart (baseline, time 1, and time 2).

Our study focused on 1247 participants of the original 1374 who provided study data at the 2007 baseline (age range, 45–74 years). Because the study focused on persistent insomnia symptoms, only individuals who provided answers to the insomnia questions at all 3 time points (spanning 4 years) were included. There were 112 participants who did not provide answers to the insomnia questions at all 3 time points, and thus were not included. Additionally, 6 participants with traumatic brain injury and 9 participants with cerebrovascular disease were excluded. An informed consent form was signed by each participant and the study procedure was approved by the institutional review board of the Korea University Ansan Hospital. See Fig. 1 for details.

2.1.1. Classification of persistent insomnia symptoms

Participants were asked to rate the frequency of the following 4 insomnia symptoms during the past month: difficulty initiating sleep, difficulty maintaining sleep, experience of early morning awakenings, and unrefreshed feeling in the morning using a 4-point Likert scale (1 = never, 2 = 1–2 times per week, 3 = 3–4 times per week, and 4 ⩾ 5 times per week). Individuals who indicated that they experienced at least one of these 4 symptoms more than 3–4 times a week (score ⩾ 3 on any one item) were categorized as having insomnia symptoms, regardless of their use of sleep medication. Insomnia groups were formed based on insomnia symptom frequency during each time point. We defined persistent insomnia symptoms as the presence of insomnia symptoms at all 3 consecutive assessments (baseline, time 1, and time 2). Remission was defined as a change from having insomnia symptoms at one time point to an absence of insomnia at the next time point.

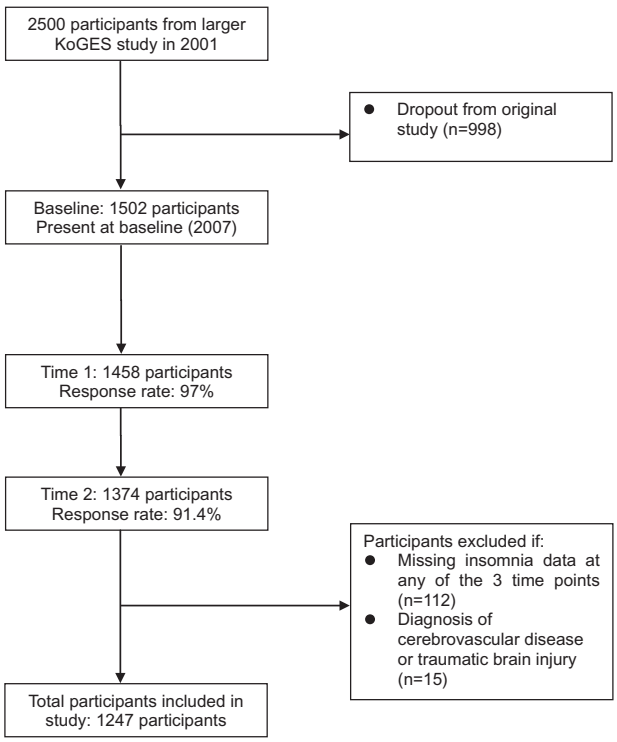

Fig. 1. Participants flowchart. *Abbreviation:* KoGES, Korean Genome and Epidemiology Study.

2.2. Measures

2.2.1. Demographic variables only measured at baseline

All participants completed information about age, gender, education, marital status, employment status, and general physical health. Demographic information can be found in Table 1.

2.2.2. Health behaviors

Smoking status was obtained by self-report and measured as a dichotomous variable (current smoker or nonsmoker). Total alcohol consumption was obtained as grams per day by calculating total beverage-specific amount of alcohol and total amount of liquor consumed [12].

2.2.3. Health

Body mass index (BMI), hypertension, and DM were assessed. At baseline, each participant's BMI was measured by a research assistant using height (cm) and weight (kg). Hypertension was defined as having systolic blood pressure $\geqslant$140 mmHg and diastolic blood pressure $\geqslant$90 mmHg, current use of antihypertensive medication, or a history of hypertension diagnosis by a physician. DM was defined as having a fasting glucose level of $\geqslant$126 mg/dL, use of any DM medication, or a history of DM diagnosis by a physician. An overnight fasting blood sample also was obtained to determine glucose and lipid levels. Systolic and diastolic blood pressures were measured 3 times with a sphygmomanometer and the average of the 3 measures was used. Presence of hypertension and DM were assessed as dichotomous variables (present or absent).

2.2.4. Beck Depression Inventory

The Beck Depression Inventory (BDI) is a 21-item self-report inventory used to assess the severity of depressive symptoms [13]. Participants are asked to indicate which statement best describes the way they have been feeling over the past 2 weeks. Total scores on the BDI range from 0 to 63 and higher scores reflect greater levels of depressive symptoms. The BDI has yielded adequate reliability estimates and has been well-validated as a measure of depressive symptoms [14]. BDI scores were calculated without the sleep item.

2.2.5. Sleep Behavior Scale

The Sleep Behavior Scale (SBS) is a 12-item self-report questionnaire that was constructed for our study to assess how often the participant practiced behaviors that have been shown to interfere with sleep. Participants were asked to indicate the frequency of sleep-interfering behaviors, including consuming alcohol before going to bed, consuming caffeinated beverages after dinner, smoking before bedtime, consuming heavy meals before bedtime, engaging in vigorous activity before bedtime, taking naps longer than 30 min, having irregular sleep and wake times, using medication for sleep, engaging in activities in bed that are not related to sleep (i.e., talking on the phone, eating), going to bed when not sleepy, staying in bed when unable to stay asleep, and worrying about not getting enough sleep. Participants were asked to rate the frequency of these behaviors based on the previous month using a 5-point Likert scale (1 = never, 2 = 1–2 times per week, 3 = 3–4 times per week, 4 $\geqslant$ 5 times per week, and 5 = every day). Internal consistency was excellent for this scale (Cronbach α, 0.97). In our sample, SBS scores also were correlated with Pittsburgh Sleep Quality Index (PSQI) scores (r = .16; P < .0001).

2.2.6. History of psychiatric illness

The presence of past or current psychiatric illness was obtained through interviewer-administered questionnaires. The participants were asked open-ended questions about the presence of a past or current psychiatric illness (e.g., "Have you been diagnosed with a psychiatric illness?" "Have you ever visited a doctor because of a psychiatric illness?" "Have you ever been hospitalized because of a psychiatric illness?" "Are you currently taking medication because of a psychiatric illness?").

2.2.7. PSQI

Participants completed the PSQI, a self-report questionnaire assessing sleep quality and disturbances over a 1-month interval [15]. The scale yields a total score that ranges from 0 to 21, with higher scores indicating more difficulties with sleep. The questionnaire also has 7 subscales, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction.

Table 1
Demographic data at baseline.

	Total sample mean (SD) or n (%) (n = 1247)	Persistent insomnia mean (SD) or n (%) (n = 112)	Other subgroup mean (SD) or n (%) (n = 1135)	P value
Age	54.32 (7.1)	53.94 (0.76)	54.36 (7.08)	ns
% Gender (men)	500 (40.1)	38 (33.9)	462 (40.7)	ns
% Education (12+)	977 (78.3)	891 (82.2)	86 (81.1)	ns
% Marital status (married)	1147 (92)	1046 (92.2)	101 (90.2)	ns
% Employment (employed)	668 (53.6)	618 (54.4)	50 (44.6)	.03
% Current smokers	152 (12.2)	14 (12.5)	138 (12.2)	ns
Alcohol consumption				
Grams/d	2.68 (6.86)	3.49 (8.03)	2.60 (6.74)	ns
BMI	24.60 (2.90)	24.46 (2.67)	24.61 (2.91)	ns
% Hypertension	433 (34.7)	41 (36.6)	392 (34.5)	ns
% Diabetes mellitus	275 (22.1)	18 (16.1)	257 (22.6)	ns
SBS	15.98 (4.06)	19.73 (5.75)	3.65 (15.61)	P<.001
% History of psychiatric illness	10 (0.8)	1 (0.9)	9 (0.8)	ns
PSQI	4.61 (2.98)	8.43 (3.75)	4.23 (2.61)	P<.001
BDI	6.21 (5.81)	10.23 (8.12)	5.82 (5.38)	P<.001
SF-12 PCS	49.52 (7.44)	46.62 (10.13)	49.80 (7.07)	P<.001
SF-12 MCS	54.85 (8.26)	48.61 (11.43)	55.46 (7.62)	P<.001
% Sleep medication (>3 times/week)	18 (1.4)	7 (6.1)	11 (1)	.001

Abbreviations: SD, standard deviation; d, day; BMI, body mass index; SBS, Sleep Behavior Scale; BDI, Beck Depression Inventory (without sleep item); PSQI, Pittsburgh Sleep Quality Index, SF-12 PCS, 12-item Short-Form health survey Physical Composite Summary; SF-12 MCS, 12-item Short-Form health survey Mental Composite Summary.
*P value calculated for difference between persistent insomnia subgroup vs other subgroup (those without insomnia symptoms at all 3 time points).

2.2.8. The 12-item Short-Form health survey

The 12-item Short-Form health survey (SF-12) is a short version of the 36-item SF health survey questionnaire and measures health-related QoL [16]. Each of the 12 questions is rated on a 5-point Likert scale and the sum of the scores is calculated with a standardized scoring algorithm. Scores can be transformed into mental composite summary (MCS) and physical composite summary (PCS) scores. Higher scores on the SF-12 composite and total scores indicate higher QoL.

2.3. Statistical analysis

For our first aim we provided descriptive statistics for sample subgroups based on the longitudinal course of insomnia symptoms over 4 years across 3 time points. For our second aim, we compared those with and without persistent insomnia symptoms on outcome measures collected at time 2. These outcome variables were chosen based on previous studies that have reported associations with chronic insomnia disorder [1–5]. Because our study did not assess insomnia disorder, these variables were chosen to investigate if persistent insomnia symptoms had similar relationships to these outcomes. These included 2 indices of mental health (BDI minus sleep item and the mental composite summary of the SF-12), the physical composite summary of the SF-12, as well as alcohol and smoking behavior. We used χ^2 statistics for dichotomous variables and repeated-measures analysis of variance for the SF-12 subscales, alcohol consumption, and BDI scores, controlling for baseline values. Effect size estimates were calculated using Cohen d for continuous variables and Cramer φ for dichotomous variables.

To address our third aim, we conducted ROC analyses using the ROC4 program [11] and included a set of established insomnia risk factors and behavioral and psychologic risk factors to identify variables and potential interactions among them that predict persistent insomnia symptoms. ROC analysis is an exploratory nonparametric technique that evaluates multiple potential predictors and provides an optimal cutoff point for each predictor, maximizing the a priori specified balance between sensitivity and specificity for predicting the outcome of interest (i.e., persistent insomnia symptoms). The advantage of this technique is that it does not make restrictive assumptions, such as collinearity, additivity, and homoscedasticity, which are necessary when using linear models. When the best predictor and optimum cutoff point is identified, the group with the success criterion is tested against a stopping rule (cutoff point significant at $P < .01$). If the stopping rule is not met, no further action is taken. If the group passes the rule, the sample is divided into 2 subgroups on the basis of the selected predictor variable. The analyses are then restarted for each of the 2 subgroups in an iterative process until the stopping rule is encountered (either a subgroup reaches a sample size of $n < 10$ or the optimal test is not statistically significant at $P < .01$). For our study, we excluded a predictor from the model after the first time it showed up in the analyses if the predictor continued to emerge as a predictor in the model. ROC analyses have been used in other studies by authors of this paper to predict clinical outcomes [17–19].

In our study, we examined predictors of persistent insomnia symptoms relative to those who had remitted, incident, or nonexistent insomnia symptoms. The dichotomous dependent variable was persistent insomnia coded as 1 if insomnia symptoms were present at all 3 time points and zero otherwise. Predictor variables included age, sex, marital status, employment status, smoking status, alcohol consumption (grams of alcohol consumed per day), presence of hypertension, presence of DM, BDI total score (without sleep item), PSQI score, BMI, SF-12 scores (both MCS and PCS), and presence sleep-interfering behaviors (measured by SBS score). These predictors were selected as they could provide clinically relevant information on persistent insomnia symptoms and were included in previous studies [2,5,8,20]. We added sleep-interfering behaviors as a predictor based on theoretical accounts of insomnia [10,21]. The weight for κ in the ROC analysis was set at 0.50, so that false negatives and false positives were given equal consideration.

3. Results

3.1. Characterization of sample: longitudinal course of insomnia

The 4-year longitudinal course of insomnia over 3 time points was examined in all participants (see Table 2) and 8 possible trajectories were identified. Overall 44.3% ($n = 553$) participants reported having insomnia symptoms during at least one time point during the study. Among participants who did not have insomnia symptoms at baseline ($n = 931$), 55.7% ($n = 694$) remained free of insomnia symptoms throughout the 4-year study period.

Among those who had insomnia symptoms at baseline ($n = 316$), 35.4% ($n = 112$) had persistent insomnia symptoms at all 3 time points. There were 43 participants (13.6%) who remitted at time 1 but experienced relapse by time 2. Further, 22.5% ($n = 71$) of participants continued to experience insomnia symptoms at time 1 but remitted at time 2, and 28.5% ($n = 90$) remitted at time 1 and remained in remission at time 2. Among those who did not have insomnia symptoms at baseline ($n = 931$), 74.5% ($n = 694$) did not report any insomnia symptoms at all 3 time points; 8.3% ($n = 77$) did not have insomnia at the first 2 time points but developed insomnia symptoms at the third; 11.1% ($n = 103$) developed insomnia at time 1 but remitted at time 2; and 6.1% ($n = 57$) developed insomnia symptoms at time 1 and continued to have insomnia at time 2.

3.2. Correlates of persistent insomnia symptoms

Table 3 depicts differences between individuals with persistent insomnia symptoms and the rest of the sample on mental and physical health outcomes at time 2. Compared to individuals who did not have persistent insomnia symptoms, those with persistent insomnia symptoms had higher depression symptom severity, excluding the sleep item (BDI-S), ($P < .001$; $d = 0.70$); they also had lower mental health QoL ($P < .001$; $d = 0.70$) and physical QoL ($P < .001$; $d = 0.27$), as measured by the SF-12. There was no significant difference for alcohol consumption ($P = .20$; $d = 0.09$) and no significant difference in smoking status between the 2 groups ($\chi^2 = 1.45$; $P = .4$; Cramer $\varphi = 0.03$).

3.3. Predictors of persistent insomnia

Results from the ROC analysis identified 3 significant predictors of persistent insomnia (see Fig. 2). At the first level, the best predictor was baseline sleep quality measured by PSQI total score, with a cutoff point of 9 ($\chi^2 = 166.50$; $P < .001$). For participants with PSQI score $\geqslant 9$, the best subsequent predictor variables were sleep-interfering behaviors (SBS scores) and the mental health component of the SF-12 (MCS scores). The best subsequent predictor variables for participants with PSQI score <9 were MCS, SBS, and physical component of the SF-12 (PCS scores).

3.3.1. PSQI $\geqslant 9$ group

Of the 146 participants who reported a PSQI score $\geqslant 9$, there were 37.7% ($n = 55$) who had persistent insomnia. This group was further differentiated by the SBS scale, with a cutoff point of 18 ($\chi^2 = 17.06$; $P < .01$). Of the 55 participants who had PSQI $\geqslant 9$ and

Table 2
Trajectory of insomnia status across 3 time points (n = 1247).

Baseline (N [%])	Time 1 (N [%])	Time 2 (N [%])
No insomnia (931 [74.6])	No insomnia (771 [61.8])	No insomnia (694 [55.7])
		Insomnia (77 [6.2])
	Insomnia (160 [12.8])	No insomnia (103 [8.3])
		Insomnia (57 [4.6])
Insomnia (316 [25.3])	No insomnia (133 [10.7])	No insomnia (90 [7.2])
		Insomnia (43 [3.4])
	Insomnia (183 [14.7])	No insomnia (71 [5.7])
		Insomnia (112 [9.0])

Table 3
Differences between individuals with and without persistent insomnia symptoms on mental and physical health outcomes (n = 1247).

Domain	Variable	Persistent insomnia group (n = 112) mean (SD) or%	No persistent insomnia group (n = 1135) mean (SD) or%	Cohen d or Cramer φ
Health-related quality of life	SF-12 PCS	46.66 (10.08)	49.07 (7.46)**	0.27
	SF-12 MCS	48.96 (10.45)	55.09 (6.43)**	0.70
Mental health	BDI (without sleep item)	13.94 (9.58)	8.05 (6.78)**	0.70
Substance use	Alcohol consumption (grams/day)	5.59 (10.86)	4.56 (10.90)	0.09
	% Smokers	9.7%	12.5%	0.03

Abbreviations: SD, standard deviation; BMI, body mass index; BDI, Beck Depression Inventory (without sleep item); PSQI, Pittsburgh Sleep Quality Index; SF-12 PCS, 12-item Short-Form health survey Physical Composite Summary; SF-12 MCS, 12-item Short-Form health survey Mental Composite Summary.
** P < .0001.

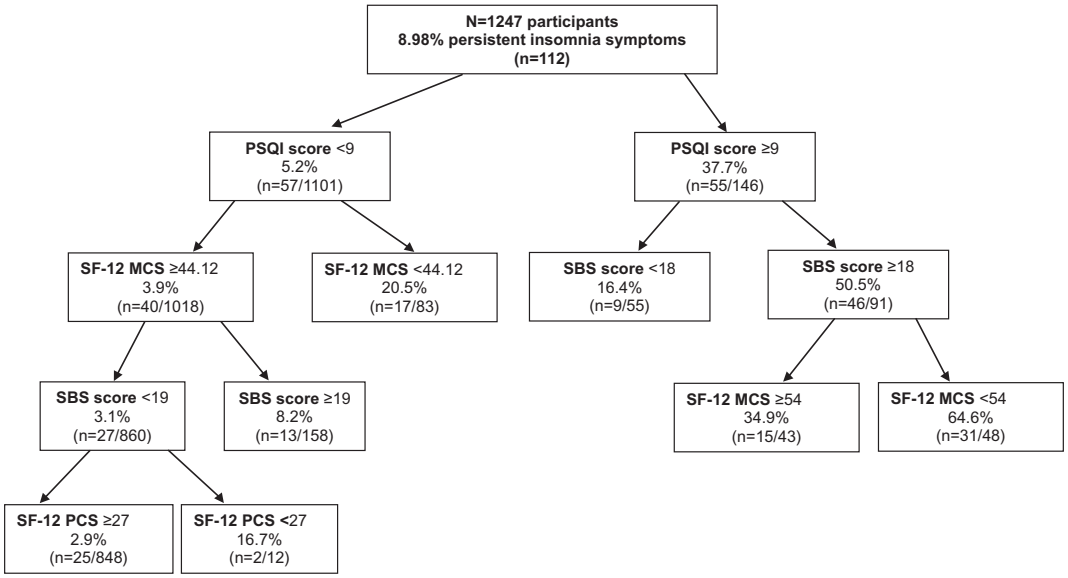

Fig. 2. Receiver operating characteristic curve tree of persistent insomnia symptoms. *Abbreviations:* PSQI, Pittsburgh Sleep Quality Index; SBS, Sleep Behavior Scale; SF-12 MCS, 12-item Short-Form health survey Mental Composite Summary; SF-12 PCS, 12-item Short-Form health survey Physical Composite Summary. The subjects who were in the persistent insomnia symptom group are in parentheses. All factors significant at P < .01 level.

SBS score <18, there were 16.4% (n = 9) who had persistent insomnia. For this group, the stopping rule went into effect and the ROC analysis did not further differentiate additional subgroups. In contrast, 50.5% (n = 46) had persistent insomnia out of the 91 participants who had PSQI ⩾9 and SBS score ⩾18. This group was further differentiated by MCS score of the SF-12, with a cutoff point of 54 (χ^2 = 8.0; P < .01). Of the 48 participants in this group who reported an MCS score <54, there were 64.6% (n = 31) who had persistent insomnia group membership. In contrast, 34.9% (n = 15) of participants had persistent insomnia group membership of the 43 participants who reported an MCS score ⩾54. At this point, the stopping rule went into effect for all groups. No other significant variables were identified in the ROC analysis.

3.3.2. PSQI <9 group

Of the 1101 participants who reported a PSQI score <9, there were 5.2% (n = 57) who had persistent insomnia. This group was further differentiated by MCS scores, with a cutoff point of 44 (χ^2 = 42.83; P < .001). For those with MCS scores <44, the stopping rule went into effect for this group. No other significant variables were identified in the ROC analysis for this subgroup. Those with MCS scores ⩾44 were further differentiated by SBS score, with a cutoff point of 19 (χ^2 = 9.15; P < .01). No other significant variables were identified for those in the SBS score ⩾19 subgroup. Those with a SBS score <19 were further differentiated by PCS scores, with a cutoff point of 27 (χ^2 = 7.32; P < .01). At this point, the stopping rule went into effect for this group. No other significant vari-

ables were identified in the ROC analysis for this group membership.

4. Discussion

A primary goal of our study was to examine the 4-year longitudinal trajectory of insomnia symptoms in the general population in Korea. Consistent with previous estimates [22] insomnia symptoms were prevalent and 44.3% reported experiencing frequent ($\geqslant$3 nights per week) symptoms during at least one time point. Insomnia symptoms also were highly persistent. Among individuals experiencing insomnia symptoms at baseline, the most common trajectory (35%) was to experience insomnia symptoms at each subsequent time point, suggesting that one-third of individuals who experienced poor sleep at least 3 times a week continued to experience these symptoms. It is noteworthy that the percentage of individuals in the sample who reported experiencing persistent insomnia symptoms (9%) was similar to findings from epidemiologic studies of the prevalence of persistent insomnia syndrome [1–3,6–8]. Like persistent insomnia syndrome, we found that individuals with persistent insomnia symptoms had higher depression symptom severity and lower physical and mental health QoL at all time points.

Our study also explored risk factors of persistent insomnia symptoms. Baseline levels of sleep quality, frequency of sleep-interfering behaviors, and poor mental health QoL emerged as the strongest predictors of persistent insomnia symptoms, even when other well-known risk factors for insomnia were entered into the model. At highest risk for persistent insomnia symptoms were those who at baseline had poor sleep quality (PSQI >8) who also frequently endorsed engaging in sleep-interfering behaviors and reported low mental health QoL. Surprisingly demographic factors, hypertension, DM, and smoking status were not significant predictors of persistent insomnia symptoms status. It is noteworthy that individuals with a PSQI score that exceeded 8 points at baseline identified by the ROC analysis were more likely to still have insomnia at follow-up in a previous study [23]. A similar cutoff point of 8.5 on the PSQI was recommended for diagnosing insomnia in a Korean population [24]. Our findings add further support to the potential utility of this cutoff score, with nearly 38% of individuals exceeding this cutoff point of having persistent insomnia symptoms over the 4-year study period.

The results from our study also highlight the importance of behavioral factors as contributors to persistent insomnia symptoms. To the best of our knowledge, our study is the first epidemiology study to find behavioral factors relevant to the persistence of insomnia symptoms. Among individuals with PSQI >8 who also had a score of 18 or higher on the SBS (reflecting a high frequency of sleep-interfering behaviors), 51% experienced persistent nocturnal insomnia symptoms compared to only 16% of those scoring below 18 on the SBS. This finding raises the intriguing possibility that behavioral treatments that directly target sleep-interfering behaviors, such as those taught in the course of cognitive behavioral therapy for insomnia (CBT-I), might be an effective preventative intervention. The public health impact of such an intervention could be high, given that persistent insomnia symptoms were associated with higher depression scores and lower physical or mental health QoL found in our current study.

Among individuals with poor sleep quality who reported engaging in more frequent sleep-interfering behaviors, those with poor mental health QoL (MCS score <54) were more likely to have persistent insomnia symptoms (64.6%) compared to those with scores of 54 or higher (34.9%). This finding is consistent with a large body of literature supporting a relationship between poor mental health and insomnia symptoms [25,26]. However, our study is unable to evaluate the temporal sequencing of these 2 factors.

Collectively our study provides important evidence of an interaction among clinical factor; that is, poor baseline sleep quality accompanied by frequent sleep-interfering behaviors and low mental health QoL distinguishes individuals with persistent (64.6%; $n = 31$) vs nonpersistent insomnia symptoms. The rate of persistent insomnia symptoms among these individuals was 64.6% ($n = 31$) compared to a rate of 5.2% ($n = 57$) among individuals who did not meet all 3 of these risk factors. This finding highlights the importance of addressing multiple risk factors in preventing transient sleep disturbance from turning into persistent insomnia.

4.1. Limitations

Despite the strengths in our study, such as the longitudinal design (e.g., 4-year study period and 3 assessment time points), a large population-based sample, and inclusion of a diverse range of potential risk factors, there are a number of limitations which also must be noted. First, our study did not assess distress associated with perceived poor sleep, and thus could not classify participants based on insomnia diagnosis. Second, sleep-disordered breathing was not assessed, which is problematic given the high rates of comorbidity between these conditions [27–33]. Additionally, our study did not include a validated assessment of psychiatric diagnosis, which complicates conclusions drawn regarding the null findings for psychiatric history predicting persistent nocturnal insomnia symptoms especially given the low prevalence of non-sleep related psychiatric problems in our sample. However, this limitation also raises an interesting issue related to the willingness of Korean individuals to endorse or seek help for psychiatric symptoms, as these are linked to certain stigmas. Indeed previous research reported that psychiatric stigmatization is more severe in Asian compared to Western countries [34,35] and are more likely to somatize symptoms than recognize having a psychiatric illness [36]. Another limitation that should be noted is that the outcome measures in our study primarily are based on subjective reports of sleep. There is ample evidence that insomnia patients have difficulty recognizing sleep state, with a propensity to misperceive sleep as wake; thus the lack of objective sleep data may limit our findings. [37] However, it is important to note that the subjective experience is necessary for a diagnosis of insomnia. Additionally, the lack of findings with health behaviors may be due to a tendency to underreport detrimental health behaviors. One additional limitation that should be noted is the low prevalence rate of treatment data found in our sample. This limitation is consistent with a previous epidemiology study [38] in which the authors found treatment rates for insomnia as low as 6.8%. The limited treatment data suggest that persistent insomnia was not due to failed treatment but rather lack of treatment.

Finally, it is important to note that the ROC analyses are inherently exploratory, and consequently findings must be viewed as tentative and used to generate hypotheses to be tested in the future. We hope that results from our ROC analysis conducted in a general population sample will stimulate further work on risk and maintaining factors for the persistence of insomnia symptoms and chronic insomnia disorder.

5. Conclusion

Among individuals experiencing nocturnal insomnia symptoms at baseline, the most common trajectory was to experience persistent insomnia symptoms at each assessment point over the 4-year study period. Insomnia symptoms were highly prevalent and persistent, which suggests that one-third of individuals will not experience spontaneous remission of their insomnia symptoms and

that they may benefit from preventive intervention. Engaging in sleep-interfering behaviors increased the risk for persistence of insomnia symptoms, suggesting that behavioral treatments that target the risk factors such as cognitive behavior therapy for insomnia might be effective in reducing the risk and merit future research.

Funding sources

Our study was supported by grants from the Korean Center for Disease Control, Prevention and the Korean Ministry for Health and Welfare, and the National Research Foundation of Korea Grant funded by the Korean Government (Grant 2005-E71001-00, Grant 2006-E71005-00, Grant 2007-E71001-00, Grant 2008-E71001-00, Grant 2009-E71002-00, Grant 2010-E71001-00, Grant 2011-E71004-0, NRF-2012-S1A5BA01).

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2013.09.024.

References

[1] Jansson-Frojmark M, Linton SJ. The course of insomnia over one year: a longitudinal study in the general population in Sweden. Sleep 2008;31:881–6.
[2] LeBlanc M, Merette C, Savard J, Ivers H, Baillargeon L, Morin CM. Incidence and risk factors of insomnia in a population-based sample. Sleep 2009;32:1027–37.
[3] Morin CM, Belanger L, LeBlanc M, Ivers H, Savard J, Espie CA, et al. The natural history of insomnia: a population-based 3-year longitudinal study. Arch Intern Med 2009;169:447–53.
[4] Savard J, Ivers H, Villa J, Caplette-Gingras A, Morin CM. Natural course of insomnia comorbid with cancer: an 18-month longitudinal study. J Clinl Oncol 2011;29:3580–6.
[5] Singareddy R, Vgontzas AN, Fernandez-Mendoza J, Liao D, Calhoun S, Shaffer ML, et al. Risk factors for incident chronic insomnia: a general population prospective study. Sleep Med 2012;13:346–53.
[6] Zhang J, Lam SP, Li SX, Yu MW, Li AM, Ma RC, et al. Long-term outcomes and predictors of chronic insomnia: a prospective study in Hong Kong Chinese adults. Sleep Med 2012;13:455–62.
[7] Komada Y, Nomura T, Kusumi M, Nakashima K, Okajima I, Sasai T, et al. A two-year follow-up study on the symptoms of sleep disturbances/insomnia and their effects on daytime functioning. Sleep Med 2012;13:1115–21.
[8] Vgontzas AN, Fernandez-Mendoza J, Bixler EO, Singareddy R, Shaffer ML, Calhoun SL, et al. Persistent insomnia: the role of objective short sleep duration and mental health. Sleep 2012;35:61–8.
[9] Suh S, Kim H, Yang HC, Cho ER, Lee SK, Shin C. Longitudinal course of depression scores with and without insomnia in non-depressed individuals: a 6-year follow-up longitudinal study in a Korean cohort. Sleep 2013;36:369–76.
[10] Spielman AJ, Glovinsky PB. The varied nature of insomnia. In: Hauri PJ, editor. Case studies in insomnia. New York, NY: Plenum Press; 1991. p. 1–15.
[11] Kraemer HC. Evaluating medical tests: objective and quantitative guidelines. Newbury Park, California: Sage Publications; 1992.
[12] Baik I, Shin C. Prospective study of alcohol consumption and metabolic syndrome. Am J Clin Nutr 2008;87:1455–63.
[13] Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. Arch Gen Psychiatry 1961;4:561–71.
[14] Beck AT, Steer RA, Garbin MG. Psychometric properties of the Beck Depression Inventory: twenty-five years of evaluation. Clin Psychol Rev 1988;8:77–100.
[15] Buysse DJ, Reynolds 3rd CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193–213.
[16] Ware JE. SF-36 physical and mental health summary scales: a manual for users of version 1. 2nd ed. Lincoln, RI: Quality Metric Incorporated; 2001.
[17] Manber R, Kraemer HC, Arnow BA, Trivedi MH, Rush AJ, Thase ME, et al. Faster remission of chronic depression with combined psychotherapy and medication than with each therapy alone. J Consult Clin Psychol 2008;76:459–67.
[18] Ong JC, Kuo TF, Manber R. Who is at risk for dropout from group cognitive-behavior therapy for insomnia? J Psychosom Res 2008;64:419–25.
[19] Suh S, Ong JC, Steidtmann D, Nowakowski S, Dowdle C, Willett E, et al. Cognition and insomnia subgroups. Cogn Ther Res 2012;36:120–8.
[20] Fernandez-Mendoza J, Vgontzas AN, Bixler EO, Singareddy R, Shaffer ML, Calhoun SL, et al. Clinical and polysomnographic predictors of the natural history of poor sleep in the general population. Sleep 2012;35:689–97.
[21] Morin CM, Stone J, Trinkle D, Mercer J, Remsberg S. Dysfunctional beliefs and attitudes about sleep among older adults with and without insomnia complaints. Psychol Aging 1993;8:463–7.
[22] Hatoum HT, Kania CM, Kong SX, Wong JM, Mendelson WB. Prevalence of insomnia: a survey of the enrollees at five managed care organizations. Am J Manag Care 1998;4:79–86.
[23] Okajima I, Komada Y, Nomura T, Nakashima K, Inoue Y. Insomnia as a risk for depression: a longitudinal epidemiologic study on Japanese rural cohort. J Clin Psychiatry 2012;73:377–83.
[24] Sohn SI, Kim do H, Lee MY, Cho YW. The reliability and validity of the Korean version of the Pittsburgh Sleep Quality Index. Sleep Breath 2012;16:803–12.
[25] Ford DE, Kamerow DB. Epidemiologic study of sleep disturbances and psychiatric disorders. An opportunity for prevention? JAMA 1989;262:1479–84.
[26] Buysse DJ, Angst J, Gamma A, Ajdacic V, Eich D, Rossler W. Prevalence, course, and comorbidity of insomnia and depression in young adults. Sleep 2008;31:473–80.
[27] Chung KF. Insomnia subtypes and their relationships to daytime sleepiness in patients with obstructive sleep apnea. Respiration 2005;72:460–5.
[28] Gooneratne NS, Gehrman PR, Nkwuo JE, Bellamy SL, Schutte-Rodin S, Dinges DF, et al. Consequences of comorbid insomnia symptoms and sleep-related breathing disorder in elderly subjects. Arch Intern Med 2006;166:1732–8.
[29] Guilleminault C, Palombini L, Poyares D, Chowdhuri S. Chronic insomnia, premenopausal women and sleep disordered breathing: part 2. Comparison of nondrug treatment trials in normal breathing and UARS postmenopausal women complaining of chronic insomnia. J Psychosom Res 2002;53:617–23.
[30] Krakow B, Melendrez D, Ferreira E, Clark J, Warner TD, Sisley B, et al. Prevalence of insomnia symptoms in patients with sleep-disordered breathing. Chest 2001;120:1923–9.
[31] Krell SB, Kapur VK. Insomnia complaints in patients evaluated for obstructive sleep apnea. Sleep Breath 2005;9:104–10.
[32] Lichstein KL, Riedel BW, Lester KW, Aguillard RN. Occult sleep apnea in a recruited sample of older adults with insomnia. J Consult Clin Psychol 1999;67:405–10.
[33] Ong JC, Gress JL, San Pedro-Salcedo MG, Manber R. Frequency and predictors of obstructive sleep apnea among individuals with major depressive disorder and insomnia. J Psychosom Res 2009;67:135–41.
[34] Kim S, Rew L. Ethnic identity, role integration, quality of life, and depression in Korean-American women. Arch Psychiatr Nurs 1994;8:348–56.
[35] Pearson V, Phillips M. Psychiatric social work and socialism: problems and potential in China. Soc Work 1994;39:280–7.
[36] Chung H, Teresi J, Guarnaccia P, Meyers BS, Holmes D, Bobrowitz T, et al. Depressive symptoms and psychiatric distress in low income Asian and Latino primary care patients: prevalence and recognition. Community Ment Health J 2003;39:33–46.
[37] Mercer JD, Bootzin RR, Lack LC. Insomniacs' perception of wake instead of sleep. Sleep 2002;25:564–71.
[38] Ohayon MM, Hong SC. Prevalence of insomnia and associated factors in South Korea. J Psychosom Res 2002;53:593–600.