HHS Public Access

Author manuscript

Aging Ment Health. Author manuscript; available in PMC 2018 November 01.

Published in final edited form as:

Aging Ment Health. 2017 November ; 21(11): 1155–1163. doi:10.1080/13607863.2016.1209735.

Enduring Sleep Complaints Predict Health Problems: A 6-Year Follow-Up of the Survey of Health and Retirement in Europe

Dr. Ephraim S. Grossman, Ph.D.,
The Interdisciplinary Department of Social Sciences, Bar-Ilan University, Israel

Dr. Amit Shrira, Ph.D., and
The Interdisciplinary Department of Social Sciences, Bar-Ilan University, Israel

Ehud Bodner, Ph.D.
The Interdisciplinary Department of Social Sciences and the Department of Music, Bar-Ilan University, Israel

Abstract

Objectives—Sleep complaints are common and enduring among old people. Studies, including prospective studies, relate sleep problems to adverse outcomes. The study aimed to extend current knowledge by exploring the effects of episodic versus chronic sleep complaints on a wide range of physical and mental health outcomes.

Methods—8,934 older adults (mean age=64 at Wave 1) who participated in waves 1, 2 and 4 of the longitudinal Survey of Health, Ageing and Retirement in Europe reported sleep and health outcome measures. Respondents were considered as having episodic sleep complaints if they complained only in the first wave (12.6%) or only in the second wave (13.0%), and with a chronic complaint, if they complained about sleep in both waves (19.5%). Outcomes in Wave 4 included physical symptoms, difficulties in activities of daily living and low quality of life.

Results—Logistic regressions examined whether episodic and chronic sleep complaints at W1 and W2 can predict W4 health outcomes. Results indicate that although episodic sleep complaints are related to a higher risk of adverse outcomes on Wave 4, chronic sleep complaints predicted worse outcomes, compared to both no sleep difficulties and compared to episodic sleep complaints, even after adjusting for demographic characteristics and previous levels of health.

Conclusion—Sleep complaints and mainly chronic sleep complaints are related to elevated risk of future health and functional problems. Caregivers are encouraged to address sleep complaints as early as possible and provide their older patients the opportunity for gaining help before the sleep complaints become persistent.

Corresponding author: Ephraim S. Grossman, Ph.D. The Interdisciplinary Department of Social Sciences, Bar-Ilan University, Ramat-Gan, Israel. Tel. -972-3-5317931, Fax. +972-3-7384039, ephraim.grossman@biu.ac.il.

Conflicts of Interest and Source of Funding: No Disclosures to Report.

Ethics: This was not an experimental study, nor was the data collected for the current study.

Keywords

Chronic sleep complaints; physical symptoms; difficulties in activities of daily living; quality of life; SHARE

Introduction

Recently, the DSM-5 (APA, 2013) had highlighted disturbed sleep as a potential warning sign for the presence of serious medical issues. Sleep disturbances increase dramatically with age (Klink & Quan, 1987; Ohayon & Roth, 2003; Roberts, Shema, Kaplan, & Strawbridge, 2000), are commonly chronic and enduring (Ohayon & Roth, 2003; Sateia, Doghramji, Hauri, & Morin, 2000) and may promote stress (Sateia et al., 2000). Patients with chronic sleep problems may complain about a wide range of serious health conditions (Gebhart, Erlacher, & Schredl, 2011; Vaz Fragoso & Gill, 2007). Thus, a self-report of sleep problems in the form of sleep complaints may serve as a signal indicating the presence of a wide range of mental and physical health problems in older adults (Ohayon & Roth, 2003), ranging from anxiety and depression to neurodegenerative diseases (Sateia et al., 2000). Acknowledging the existence of a sleep problem can promote intervention and further attempts to diagnose health problems (Sampaio, Sewo Sampaio, Yamada, Tsuboyama, & Arai, 2014).

Despite the chronic nature of sleep disturbances, few studies directly addressed the effect of its actual chronicity, i.e. of an enduring disturbance, on physical and mental outcomes. The goal of the present study is to reexamine if sleep complaints in general predict future health decrements, and to further examine whether chronicity of sleep complaints predict more future health decrements above and beyond existing medical states and episodic sleep complaints.

High prevalence of insomnia is commonly reported in older adults. In a large Western European sample (N=14,915), Ohayon and Roth (2003) found rates of reported insomnia to increase with age. In the 1995 wave of a longitudinal study in California, about a fourth of the participants over 50 years old reported insomnia (Roberts et al., 2000). Nearly the same range, 20–40%, was mentioned by Sateia et al. (2000) in their report about the prevalence of insomnia complaints found in epidemiologic investigations of elderly individuals. The persistent nature of insomnia can be also seen in large-scale surveys (e.g., Mallon, Broman, & Hetta, 2000), where 75% of sleep complaints of people aged 45–65 reappeared 12 years later at follow-up.

Self-reported and objective sleep problems are linked with negative long-term health outcomes. Reports of short sleep duration and difficulties in initiating and maintaining sleep were found as risk factors for the development of diabetes and coronary artery disease over a period of 12 years (Mallon, Broman, & Hetta, 2002; Mallon, Broman, & Hetta, 2005). In a study of older Japanese adults, a simple self-assessment of sleep quality was associated with “lifestyle characteristics, cognitive status, nutrition, depression, seclusion and quality of life” (Sampaio et al., 2014, p. 631). Pollak, Perlick, Linsner, Wenston, and Hsieh (1990) reported both low and high rates of insomnia as associated with long-term outcomes, including

mortality and nursing home placement among elderly men. Other prospective epidemiological studies have shown that in people over 45 years of age, subjective sleep complaints can predict the development of obesity and metabolic pathology (Troxel et al., 2010). After reviewing a wide range of health outcomes modeled in experimentally induced short-term sleep deprivation, Mullington, Haack, Toth, Serrador, and Meier-Ewert (2009) concluded that chronic under-sleeping may contribute to factors priming otherwise healthy individuals to develop a disease. In their view, this factor must be considered especially for health risk management of aging people. In some population-based surveys on a wide age range of adults who were diagnosed as suffering from insomnia, their sleep complaints were also found to be correlated with depression, psychological and health-related quality of life impairments (LeBlanc et al., 2007) and cognitive decline (Fortier-Brochu, Beaulieu-Bonneau, Ivers, & Morin, 2012). Among older adults in particular, self-reported sleep complaints were related to cognitive decline (Jelicic et al., 2002) and mobility disorders (Malinowska et al., 2015). Schubert et al. (2002) suggested that rather than just marking the existence of other conditions, sleep problems in older adults may have an independent effect on their quality of life. Furthermore, Vaz Fragoso and Gill (2007) emphasize that sleep problems can be related to other conditions in a bidirectional way. Whether a sleep problem is primary or secondary to another source, it can accelerate age-related physiological or health declines.

A variety of environmental, behavioral, health and medication-related factors, together with biological changes that accompany ageing, can all contribute to sleep fragmentation (Ancoli-Israel & Kripke, 1991). Each one, and a combination of these factors, can contribute to poor sleep and to the sleep complaints seen in older adults. Thus, the chronicity of sleep problems among older adults is not surprising. Accordingly, in a close follow-up of patients seen in a sleep clinic, Rosenthal, Dolan, Taylor, and Grieser (2008) found that the majority continue to report insomnia 3–5 years later. Studies considering the extent of the sleep problem show that among older adults, the more sleep problems the lower the quality of life (Schubert et al., 2002). Using a different perspective, Roberts et al. (2000) found that while sleep complaints in an aging population are a strong predictor of depression in the following year, an enduring complaint about sleep at baseline and a year after, accounts for a much stronger risk factor.

Lately, the adverse outcomes of inadequate sleep (Reynold & O'Hara, 2013) were highlighted as an independent risk factor for several psychopathologies (APA, 2013). Thus, in the present study, we investigate whether chronic sleep problems increase the risk of health and functional decline above and beyond existing health issues and episodic sleep problems, among older adults. In this study, we relate to a wider scope of variables and timespan than did Roberts et al. (2000), who looked at the relations between depression and a sleep problem that persisted for one year. We used data from a longitudinal, large-scale-multinational European survey on the second half of life, and chose to relate to a distinction between complaints of episodic and chronic sleep problems with respect to their appearance over a two years period. We expected that compared to episodic sleep complaints, chronic sleep complaints will have a more adverse effect on health outcomes (physical symptoms, difficulties in activities of daily living and low quality of life) reported four years later.

Method

Participants and Procedure

Data were drawn from the two first waves and the fourth wave of the Survey of Health, Ageing, and Retirement in Europe (SHARE; Börsch-Supan et al., 2008). The SHARE data include persons aged 50 years and older from a dozen countries, and their spouses of any age. Based on probability samples of households in each participating country, SHARE represents the community-dwelling older population. The data were collected by a comprehensive computer-assisted personal interview, which lasted about 90 minutes, and a supplementary paper Drop-Off questionnaire, which was generally returned later. In the computer-assisted interview, interviewers read the questions to the interviewees and typed their answers. The paper Drop-Off questionnaires were completed by the respondents. Informed consent had been obtained from all respondents prior to the interview.

In total, 31,115 respondents participated at Wave 1 (W1, 2004). Of them, 18,742 participated at Wave 2 (W2, 2006), and of them 9,531 participated at Wave 4 (W4, 2010).[1] The current investigation was limited to 8,934 respondents who were aged 50 years and older in W1 and participated in W1, W2 and W4. These respondents were interviewed in 10 countries (Austria, Belgium, Denmark, France, Italy, Netherlands, Germany, Spain, Sweden, and Switzerland). The mean age (at W1) was 63.71 (SD = 8.97, range = 50–95), and 55.5% were women, 32.4% had primary education or below, 44.7% had lower to upper secondary education, and 22.8% had post-secondary education or above, 74.1% were married, 13.6% were widowed, 7.0% were divorced, and 5.4% were single, mean annual household income (in Euro) was 45,175 (SD = 55,339), and 51.9% were working.

Attrition analyses, focusing on those who were 50 or older, showed that those who participated in W1 only (n = 10,201) were older, included a greater ratio of men, and had lower education and lower household income than those who participated in all three waves (n = 8,934). However, the size of these differences was small to negligible (Cohen's d for age and household income was .20 and .13, respectively; φ for gender and Cramer's V for education was .020 and .025, respectively).

Measures

Sleep complaints were assessed in the first two waves with a single item taken from the European Depression scale (Euro-D; Prince et al., 1999). Respondents were asked whether they had trouble sleeping recently and either answered having "trouble with sleep (or recent change in pattern)" or having "no trouble sleeping." This single item is similar to that used in previous studies that assessed sleep problems in large-scale surveys (e.g. Dregan & Armstrong, 2011). We further divided respondents into those who reported no sleep disturbances, those who reported sleep disturbances in W1 only or in W2 only (episodic complaints), and those who reported sleep disturbances in both waves (chronic complaints).

[1]Data from Wave 3 (2008) was not used in the current study, as it constituted a retrospective inquiry into the life stories of the participants, and did not include questions regarding sleep disturbances or other health outcomes.

Outcomes included three major markers of health: physical symptoms, difficulties in activities of daily living (ADL) and quality of life. Physical symptoms were assessed by summing nine listed health conditions that respondents reported to have been bothered by for the past six months (pain in joints or various other body parts, heart trouble or angina, difficulty breathing, persistent cough, swollen legs, falling down, dizziness faints or blackouts, stomach or intestine problems, and incontinence or involuntary loss of urine). Difficulties in ADL were assessed by summing everyday activities adapted from Katz, Downs, Cash, and Grotz (1970) that participants reported to have been limited in their performance (dressing, including putting on shoes and socks, walking across a room, bathing or showering, eating, such as cutting up food, getting in or out of bed, and using the toilet, including getting up or down) Kuder-Richardson coefficient was .71, .75, and .84, for W1, W2, and W4, respectively). Quality of life was measured by 12 items originating from the CASP-19 (Hyde, Wiggins, Higgs, & Blane, 2003) referring to having a sense of control, autonomy, self-realization, and pleasure, with a scale ranging from “never” (1) to “often” (4) (Cronbach’s α was .80 for both W2 and W4).

Covariates included in the analysis were treated as follows: geographic region of respondents was divided into Mediterranean countries (France, Italy and Spain) and non-Mediterranean (all other countries; cf. Litwin, 2009). Age, divided into those 50–59, 60–69, and 70 or above, and gender. Education was recorded by classifying the participants into one of three education levels according to the International Standard Classification of Educational Degrees (ISCED-97) (UNESCO, 1997): primary education or below, lower to upper secondary education, and post-secondary education or above. Marital status (married versus those not married [never married; divorced; widowed]) was also included together with household income, assessed according to the gross annual income (in Euro) adjusted for relative purchasing power parity within the participating SHARE countries and standardized by the household size square root to get the equivalent disposable income per standard person. Work status (not working; working) was another covariate. We also controlled for cognitive functioning that following Kavé, Shrira, Palgi, Spalter, Ben-Ezra, and Shmotkin (2012) was consisted of three domains. (I) Verbal recall was assessed by the number of words out of a 10-word list recalled 5 minutes after presentation (the adapted Ten-Word Delay Recall Test; Prince, Acosta, Chiu, Scazufca, & Varghese, 2003). (II) Word fluency was assessed by the number of correct animal names produced within 1 minute. As the distribution of word fluency scores was highly skewed, respondents whose score fell more than three standard deviations above the mean group score (e.g., greater than 40) were given a score of 40. (III) Arithmetic ability was assessed by the number of correct answers to four arithmetic questions (e.g., “if the chance of catching a disease is 10%, how many people out of 1,000 are expected to catch the disease?”). A composite score of these three cognitive measures was calculated. First, the scores in each domain were standardized and then the standardized scores were averaged to a composite score, with a higher score representing better cognitive functioning. Finally, we controlled for the W1 level of the non-regressed outcomes and for the W1 and W2 level of the regressed outcomes (except for quality of life, which was measured for only a part of the sample in W1).

Data analysis

We first performed descriptive analysis of sleep complaints, and further examined in a series of logistic regressions whether they predicted W4 health outcomes without adjusting for covariates (Model 1). Physical symptoms and difficulties in ADL were dichotomized to indicate no symptoms/difficulties (0) and one or more symptoms/difficulties. This was done as distribution of symptoms was skewed towards no symptoms/difficulties. Quality of life was dichotomized to indicate low quality of life according to the median (below median = 1; at or above median = 0). The reference category was no sleep complaints, and the other categories included those with episodic and chronic sleep complaints. Covariates were added in the following order: geographic origin (Model 2), background characteristics (age, gender, education, marital status, household income, working status) and cognitive functioning (Model 3), W1 level of the non-regressed outcomes (Model 4. Note that for quality of life we used W2 levels as it was not consistently measured in W1, as mentioned above), and both W1 and W2 level of the regressed outcome (Model 5).

In order to examine the main research question, we further performed Model 5 treating sleep complaints in W2 only as the reference category, comparing them to the other groups (those with no sleep complaints, those with complaints in W1 only, and those with chronic complaints). These analyses examined whether chronicity of sleep complaints predicts health problems above and beyond episodic complaints occurring at the same period (i.e., both episodic and chronic complaints took place in W2). Odds ratio (OR) and 95% confidence interval (CI) are reported, and Nagelkerke R^2 refers to the variance of W4 level of outcomes explained by each model. All statistical analyses were performed using SPSS ver. 23.

Results

Descriptive statistics and unadjusted models

More than a half of the final (W4) sample (54.9%) reported to have no sleep problems, 12.6% of them reported to have disturbed sleep in W1 only, 13.0% complained about sleep in W2 only, and 19.5% reported chronic complaints, i.e. sleep disturbances across both first waves. Table 1 presents the distribution of the four sleep disturbance groups across age groups and gender. As can be seen, the percentage of chronic sleep disturbances was around 19–20% across age groups. The percentage of chronic sleep disturbances was higher among women (25.3%) than among men (12.3%).

Table 2 presents the models predicting physical symptoms. In Model 1, relative to those with no sleep complaints, those with sleep complaints in W1 or in W2 only had a higher chance of physical symptoms (OR=1.58, 95%CI=1.35–1.84, and OR=1.50, 95%CI=1.28–1.74, respectively). Notably, the chance for physical symptoms was double among those with chronic sleep complaints (OR=2.42, 95%CI=2.10–2.80). After controlling for the various covariates (Model 5), the higher chance of physical symptoms remained significant among those with sleep complaints in W1 only (OR=1.19, 95%CI=1.00–1.41) and among those with chronic sleep complaints (OR=1.31, 95%CI=1.12–1.54).

Table 3 presents the models predicting difficulties in ADL. Again, the unadjusted model (Model 1) showed that those with sleep complaints in W1 or in W2 only had a higher chance of difficulties in ADL (OR=1.32, 95%CI=1.07–1.61, and OR=1.46, 95%CI=1.20–1.77, respectively) compared to those with no sleep complaints. Similarly to physical symptoms, the chance for difficulties in ADL was double among those with chronic sleep complaints (OR=2.16, 95%CI=1.85–2.52). After controlling for the various covariates (Model 5), the higher chance of difficulties in ADL remained significant only among those with chronic sleep complaints (OR=1.33, 95%CI=1.11–1.60).

Table 4 presents the models predicting low quality of life. Model 1 showed that relative to those without sleep complaints, the chance for low quality of life was higher among those with sleep complaints in W1 or in W2 only (OR=1.53, 95%CI=1.33–1.75, and OR=1.63, 95%CI=1.42–1.87, respectively), as well as among those with chronic sleep complaints, where the chance was doubled (OR=2.36, 95%CI=2.09–2.66). After controlling for covariates (Model 5), the higher risk of low quality of life remained significant in all three groups with sleep complaints (for sleep complaints at W1 only: OR=1.25, 95%CI=1.07–1.46; for sleep complaints at W2 only: OR=1.21, 95%CI=1.03–1.41; for chronic sleep complaints: OR=1.53, 95%CI=1.33–1.76).

Table 5 presents the coefficients for the sleep disturbance groups after controlling for covariates (Model 5) when using episodic sleep complaints in W2 as the reference category. As can be seen, relative to those with sleep complaints in W2 only, those with no sleep complaints had a lower chance of low quality of life (OR=0.82, 95%CI=0.70–0.96), but more importantly, those with chronic sleep complaints had a higher chance of physical symptoms (OR=1.32, 95%CI=1.07–1.62), difficulties in ADL (OR=1.27, 95%CI=1.00–1.61), and low quality of life (OR=1.26, 95%CI=1.05–1.52) in W4.

Supplementary Analyses

We also performed additional analyses keeping the outcome variables continuous. Using hierarchical linear regression models, we regressed the continuous outcomes on all covariates using a three-level sleep disturbance variable as the main predictor (0=no sleep disturbance, 1=episodic sleep disturbance [either in W1 or W2], and 2=chronic disturbance). Sleep disturbance explained 4.8% of the variance in W4 physical symptoms (B=0.38, β=0.21, p<.0001), and remained a significant predictor after controlling for covariates (B=0.16, β=0.09, p<.0001). Sleep disturbance explained 0.8% of the variance in W4 difficulties in ADL (B=0.10, β=0.09, p<.0001), and remained a significant predictor after controlling for covariates (B=0.03, β=0.02, p<.05). Finally, sleep disturbance explained 5.1% of the variance in W4 quality of life (B=−1.79, β=−0.22, p<.0001), and remained a significant predictor after controlling for covariates (B=−0.84, β=−0.10, p<.0001).

Discussion

The main finding that emerges from the analysis of data collected on the SHARE project over six years is that enduring sleep complaints are related to greater chance of future health and functional problems beyond episodic sleep complaints. This increase of 26%–32% verifies the relative importance of enduring sleep complaints as a risk factor for physical

symptoms, difficulties in ADL and low quality of life four years later. At the same time, episodic sleep complaints are related with more negative outcomes compared to non-sleep complaints, but some of these effects became non-significant when controlling for demographics and previous levels of health outcomes.

Similar to prior studies (Ohayon & Roth, 2003; Roberts et al., 2000; Sateia et al., 2000), about a fourth of old aged respondents reported episodic sleep disturbances (either at W1 or at W2). In accordance to previous studies (Mallon, et al., 2000; Rosenthal, et al., 2008), in the present sample the majority of the participants who had a sleep complaint in W1 were still complaining at the time of W2. In fact, about a fifth related to an enduring sleep complaint of two years or more.

Previous research has shown that sleep quality is related to a broad range of health and functioning factors (Jelicic et al., 2002; Malinowska et al., 2015). Prospective studies can clarify some of the questions about the nature of these relations, as sleep complaints were found to be a precursor of some of these factors and a result of other health and functioning factors. Roberts et al. (2000) showed that a chronic sleep complaint is a better predictor of mental health than episodic sleep complaints. However, their data was limited to relating immediate outcomes to sleep complaints which persist over only one year referenced to episodic sleep complaints. The current analysis uses a longer epoch for characterizing chronic sleep complaints, and broadens the scope of outcomes. Another important difference is of looking at outcomes four years after the sleep complaint rather than just at the immediate phase. It is indeed important to measure immediate outcomes in order to prevent physical and mental health problems. Nevertheless, the prevention of the risk of a long-term deterioration over a broad range of physical and mental health factors among older adults can even be more cost effective for the health system. To the best of our knowledge, this is the first prospective study of older men and women that used chronic sleep complaints as predictors of various health outcomes four years later.

The fact that chronic sleep complaints can better predict adverse outcomes can be easily implemented in a medical examination by asking older adults about their quality of sleep, which in many occasions is unrecognized and untreated (Sateia et al., 2000). A decade passed since it was found that physicians lack alertness to sleep disorders (Sateia et al., 2000), and our results demonstrate that complaints about sleep can still persist over years, and are a serious problem for older adults, deserving more investigation (See also, Shah, Sharmna, & Kablinger, 2014).

The chronic aspect of a sleep complaint seems to be important even after controlling for a myriad of health and functional variables. In the current results, adverse outcomes at W4, which were predicted by their existence at W1 and at W2 and by demographic variables and cognitive functioning were also further predicted by chronic sleep complaints. In a recent study, Zaslavsky, LaCroix, Hale, Tindle, and Shochat (2015) reported that episodic and chronic insomnia similarly increase the risk of functional impairment. However, the difference between the results of the two studies may reflect either the fact that Zaslavsky et al. (2015) used a large-scale cohort of only women, or that they used a measure of outcomes taken at the same time as the second rating of insomnia, while in the current study we used

outcomes taken at W4, two years after the chronicity of the sleep complaint was established. In addition, the methodology we used was rigorous, as we related to W4 outcomes while controlling for levels of other outcomes at W1 and of the same outcome at W1 and W2.

Sampaio et al. (2014) concluded that screening older adults for their sleep characteristics can help early detection of individuals at risk for developing health problems and low quality of life. However, their study was restricted to Japanese older people and did not use a longitudinal design. The current results, which are based on a large epidemiologic survey, emphasize that a short question about a sleep disturbance can attest about the chronicity of that sleep problem. Our results also show that in older people, an indication of a sleep problem over a period of two years is related to a development of physical symptoms, functional disabilities, and reduced quality of life four years later, even if it was not diagnosed as insomnia. A sleep problem can lead to greater vulnerability, to physiological declines, and to increases in disease prevalence in community-living older persons (Vaz Fragoso & Gill, 2007). Accordingly, when a complaint about sleep becomes chronic, it is followed by an increased chance of a negative outcome compared to an episodic complaint. Thus, leaving a chronic sleep disturbance untreated may increase the chance of physical and mental health problems (Skaer & Sclar, 2010). Alternatively, addressing a complaint about a sleep problem and recommending treatment may help older adults to mitigate some of the physical and mental health problems, which may emerge four years later and save economic burdens. Our results indicate that noticing that a sleep complaint becomes chronic is meaningful even when one of the outcomes is recognized.

A previous study by LeBlanc and colleagues (LeBlanc et al., 2007) established a positive correlation between level of low quality of life and insomnia severity. It also showed that factors associated with clinical samples of insomnia emerge in a sample constituted of adults at a very wide age range (18–83) reporting a sleep problem, which do not account to a clinical definition of insomnia. Although the researchers related to the nature of complaints, they did not examine the chronicity of the sleep problem as in this study. Yet, the results of the current study are in line with these previous findings in respect to the linear relations between the severity of the sleep problem and of its adverse physical and mental outcomes. At some point, when a sleep problem becomes chronic, it can turn into an additional risk factor for health and mental problems. The source of the hazard may be either accumulation of sleep debt and hyperarousal (Johnson, Roth, & Breslau, 2006), or the psychological strain posed when one realizes that the sleep problem is chronic.

The findings should be viewed in light of the study’s limitations. Sleep complaints were only validated by a single item self-report measure of disturbed sleep. Yet, the use of sleep complaints for sleep disturbance is common in epidemiological studies (e.g., Dregan & Armstrong, 2011), as they were found to be highly correlated with objective measures of sleep disturbance (Mallon et al., 2002). In addition, subjective assessments can detect differences in one’s sleep characteristics even better than some objective measures (Sampaio et al., 2014). Another limitation is the lack of controlling for participants’ anxiety level, which, according to previous reports (e.g., Johnson et al., 2006), predicts sleep disturbance and plays a role in the course of the development of depression. Finally, it should be noted that the data does not include information about the use of sleeping medications, which can

potentially confound sleep complaints (Sampaio et al., 2014). Despite these limitations, the fact that the present study is based on three waves of a longitudinal study is an obvious strength, as it utilizes a perspective of stability over time. This study is one of the few studies, which prospectively examine the ability of long-term sleep complaints to predict a range of outcomes in a large European sample of older adults at three waves along six years.

In summary, recent modifications advocated by DSM-5 (APA, 2013) regard insomnia as an important medical problem. Our results, which are based on a large sample, emphasize the robustness of chronic sleep complaints as an issue of concern and support its enduring nature. Practitioners, especially of older people, are encouraged to be alert to sleep complaints, ask about sleep states, take measures to identify causes of sleep complaints and subsequently recommend suitable treatment.

Acknowledgments

Support, sponsors and grants – None.

This paper uses data from SHARE wave 1 and 2 release 2.5.0, as of May 24th 2011, and SHARE wave 4 release 1.1.1, as of March 28th 2013. The SHARE data collection has been primarily funded by the European Commission through the 5th Framework Programme (project QLK6-CT-2001-00360 in the thematic programme Quality of Life), through the 6th Framework Programme (projects SHARE-I3, RII-CT-2006-062193, COMPARE, CIT5-CT-2005-028857) and through the 7th Framework Programme (SHARE-PREP, N° 211909, SHARE-LEAP, N° 227822 and SHARE M4, N° 261982). Additional funding from the U.S. National Institute on Aging (U01 AG09740-13S2, P01 AG005842, P01 AG08291, P30 AG12815, R21 AG025169, Y1-AG-4553-01, IAG BSR06-11 and OGHA 04-064) and the German Ministry of Education and Research as well as from various national sources is gratefully acknowledged (see www.share-project.org for a full list of funding institutions.

References

American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5. Washington, DC: American Psychiatric Association; 2013.

Ancoli-Israel S, Kripke DF. Prevalent sleep problems in the aged. Biofeedback and Self-Regulation. 1991; 16:349–359. DOI: 10.1007/BF00999989 [PubMed: 1760457]

Börsch-Supan, A., Brugiavini, A., Jürges, H., Kapteyn, A., Mackenbach, J., Siegrist, J., Weber, G. Starting the longitudinal dimension. Mannheim: MEA; 2008. First results from the Survey of Health, Ageing and Retirement in Europe (2004–2007).

Dregan A, Armstrong D. Cross-country variation in sleep disturbance among working and older age groups: an analysis based on the European Social Survey. International Psychogeriatrics. 2011; 23:1413–1420. DOI: 10.1017/S1041610211000664 [PubMed: 21554795]

Fortier-Brochu E, Beaulieu-Bonneau S, Ivers H, Morin CM. Insomnia and daytime cognitive performance: A meta-analysis. Sleep Medical Review. 2012; 16:83–94. DOI: 10.1016/j.smrv.2011.03.008

Gebhart C, Erlacher D, Schredl M. Moderate exercise plus sleep education improves self-reported sleep quality, daytime mood, and vitality in adults with chronic sleep complaints: A waiting list-controlled trial. Sleep Disorders. 2011; :1–11. Article ID 809312. DOI: 10.1155/2011/809312

Hyde M, Wiggins RD, Higgs P, Blane D. A measure of quality of life in early old age: The theory, development and properties of a needs satisfaction model (CASP-19). Aging and Mental Health. 2003; 7:186–194. DOI: 10.1080/1360786031000101157 [PubMed: 12775399]

Jelicic M, Bosma H, Ponds RW, Van Boxtel MP, Houx PJ, Jolles J. Subjective sleep problems in later life as predictors of cognitive decline. Report from the Maastricht Ageing Study (MAAS). International Journal of Geriatric Psychiatry. 2002; 17:73–77. DOI: 10.1002/gps.529 [PubMed: 11802234]

Johnson EO, Roth T, Breslau N. The association of insomnia with anxiety disorders and depression: exploration of the direction of risk. Journal of Psychiatric Research. 2006; 40:700–708. DOI: 10.1016/j.jpsychires.2006.07.008 [PubMed: 16978649]

Katz SC, Downs TD, Cash HR, Grotz RC. Progress in development of the index of ADL. Gerontologist. 1970; 10:20–30. DOI: 10.1093/geront/10.1_Part_1.20 [PubMed: 5420677]

Kavé G, Shrira A, Palgi Y, Spalter T, Ben-Ezra M, Shmotkin D. Formal education level versus self-rated literacy as predictors of cognitive aging. Journal of Gerontology: Psychological Sciences and Social Sciences. 2012; 67:697–704. DOI: 10.1093/geronb/gbs031

Klink M, Quan SF. Prevalence of reported sleep disturbances in a general adult population and their relationship to obstructive airways diseases. CHEST Journal. 1987; 91:540–546. DOI: 10.1378/chest.91.4.540

LeBlanc M, Beaulieu-Bonneau S, Merette C, Savard J, Ivers H, Morin CM. Psychological and health-related quality of life factors associated with insomnia in a population-based sample. Journal of Psychosomatic Research. 2007; 63:157–166. DOI: 10.1016/j.jpsychores.2007.03.004 [PubMed: 17662752]

Litwin H. Social networks and well-being: A comparison of older people in Mediterranean and non-Mediterranean countries. Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2009; 65:599–608. DOI: 10.1093/geronb/gbp104

Malinowska KB, Okura M, Ogita M, Yamamoto M, Nakai T, Numata T, Arai H. Effect of self-reported quality of sleep on mobility in older adults. Geriatrics & Gerontology International. 2015; 16:266–271. DOI: 10.1111/ggi.12468 [PubMed: 25690528]

Mallon L, Broman JE, Hetta J. Relationship between insomnia, depression, and mortality: A 12-Year follow-up of older adults in the community. International Psychogeriatrics. 2000; 12:295–306. DOI: 10.1017/S1041610200006414 [PubMed: 11081951]

Mallon L, Broman JE, Hetta J. Sleep complaints predict coronary disease mortality in males: a 12-year follow-up study of a middle-aged Swedish population. Journal of Internal Medicine. 2002; 251:207–216. DOI: 10.1046/j.1365-2796.2002.00941.x [PubMed: 11886479]

Mallon L, Broman JE, Hetta J. High incidence of diabetes in men with sleep complaints or short sleep duration. Diabetes Care. 2005; 28:2762–2767. [PubMed: 16249553]

Mullington JM, Haack M, Toth M, Serrador JM, Meier-Ewert HK. Cardiovascular, inflammatory, and metabolic consequences of sleep deprivation. Progress in Cardiovascular Diseases. 2009; 51:294–302. DOI: 10.1016/j.pcad.2008.10.003 [PubMed: 19110131]

Nordin M, Westerholm P, Alfredsson L, Akerstedt T. Social support and sleep. Longitudinal relationships from the WOLF-study. Psychology. 2012; 3:1223–1230. DOI: 10.4236/psych.2012.312A181

Ohayon MM, Roth T. Place of chronic insomnia in the course of depressive and anxiety disorders. Journal of Psychiatric Research. 2003; 37:9–15. DOI: 10.1016/S0022-3956(02)00052-3 [PubMed: 12482465]

Pollak CP, Perlick D, Linsner JP, Wenston J, Hsieh F. Sleep problems in the community elderly as predictors of death and nursing home placement. Journal of Community Health. 1990; 15:123–135. DOI: 10.1007/BF01321316 [PubMed: 2355110]

Prince M, Acosta D, Chiu H, Scazufca M, Varghese M. Dementia diagnosis in developing countries: A cross-cultural validation study. Lancet. 2003; 361:909–917. DOI: 10.1016/S0140-6736(03)12772-9 [PubMed: 12648969]

Prince MJ, Reischies F, Beekman AT, Fuhrer R, Jonker C, Kivela SL, Van Oyen H. Development of the EURO-D scale--a European, Union initiative to compare symptoms of depression in 14 European centres. The British Journal of Psychiatry. 1999; 174:330–338. DOI: 10.1192/bjp.174.4.330 [PubMed: 10533552]

Reynolds CF, O'Hara R. DSM-5 sleep-wake disorders classification: Overview for use in clinical practice. American Journal of Psychiatry. 2013; 170:1099–1101. DOI: 10.1176/appi.ajp.2013.13010058 [PubMed: 24084814]

Roberts RE, Shema SJ, Kaplan GA, Strawbridge WJ. Sleep complaints and depression in an aging cohort: a prospective perspective. American Journal of Psychiatry. 2000; 157:81–88. DOI: 10.1176/ajp.157.1.81 [PubMed: 10618017]

Rosenthal LD, Dolan DC, Taylor DJ, Grieser E. Long-term follow-up of patients with insomnia. Proceedings (Baylor University Medical Center). 2008; 21:264–265. [PubMed: 18628925]

Skaer TL, Sclar DA. Economic implications of sleep disorders. Pharmaocoeconomics. 2010; 28:1015–1023. DOI: 10.2165/11537390-000000000-00000

Sampaio RAC, Sewo Sampaio PY, Yamada M, Tsuboyama T, Arai H. Self-reported quality of sleep is associated with bodily pain, vitality and cognitive impairment in Japanese older adults. Geriatrics & Gerontology International. 2014; 14:628–635. DOI: 10.1111/ggi.12149 [PubMed: 24118882]

Sateia MJ, Doghramji K, Hauri PJ, Morin CM. Evaluation of chronic insomnia. An American Academy of Sleep Medicine review. Sleep. 2000; 23:243–308. [PubMed: 10737342]

Schubert CR, Cruickshanks KJ, Dalton DS, Klein BE, Klein R, Nondahl DM. Prevalence of sleep problems and quality of life in an older population. Sleep. 2002; 25:889–893. [PubMed: 12489896]

Shah C, Sharma TR, Kablinger A. Controversies in the use of second generation antipsychotics as sleep agent. Pharmacological Research. 2014; 79:1–8. DOI: 10.1016/j.phrs.2013.10.005 [PubMed: 24184858]

Troxel WM, Buysse DJ, Matthews KA, Kip KE, Strollo PJ, Hall M…, Reis SE. Sleep symptoms predict the development of the metabolic syndrome. Sleep. 1997; 33:1633–1640.

United Nations Educational, Scientific and Cultural Organization (UNESCO). International Standard Classification of Education. Geneva: UNESCO; 1997.

Vaz Fragoso CA, Gill TM. Sleep complaints in community-living older persons: a multifactorial geriatric syndrome. Journal of the American Geriatrics Society. 2007; 55:1853–1866. [PubMed: 17916123]

Zaslavsky O, LaCroix AZ, Hale L, Tindle H, Shochat T. Longitudinal changes in insomnia status and incidence of physical, emotional, or mixed impairment in postmenopausal women participating in the Women's Health Initiative (WHI) study. Sleep Medicine. 2015; 16:364–371. DOI: 10.1016/j.sleep.2014.11.008 [PubMed: 25620200]

Table 1

Distribution of Sleep Disturbance Groups as a Function of Geographic Origin, Background Characteristics, Cognitive Functioning, and Wave 4 Outcomes

	No sleep disturbances *n* [%]	Sleep disturbances at W1 only *n* [%]	Sleep disturbances at W2 only *n* [%]	Chronic sleep disturbances *n* [%]
Geographical region				
Not Mediterranean	3773 [77.7]	828 [74.3]	872 [76.2]	1309 [75.9]
Mediterranean	1080 [22.3]	286 [25.7]	273 [23.8]	415 [24.1]
Age				
50–59	1833 [37.8]	439 [39.4]	454 [39.7]	645 [37.4]
61–69	1743 [35.9]	397 [35.6]	379 [33.1]	591 [34.3]
70+	1277 [26.3]	278 [25.0]	312 [27.2]	488 [28.3]
Gender				
Men	2578 [53.1]	421 [37.8]	445 [38.9]	483 [28.0]
Women	2275 [46.9]	693 [62.2]	700 [61.1]	1241 [72.0]
Education				
Primary or below	1420 [29.4]	390 [35.4]	378 [33.3]	640 [37.5]
Lower to upper secondary	2222 [46.1]	445 [40.3]	515 [45.4]	754 [44.2]
Post-secondary or above	1181 [24.5]	268 [24.3]	242 [21.3]	313 [18.3]
Marital status				
Not married	1122 [23.3]	305 [27.8]	299 [26.4]	547 [32.0]
Married	3692 [76.7]	792 [72.2]	832 [73.6]	1162 [68.0]
Household income				
Low tertile	1468 [30.3]	377 [33.8]	429 [37.5]	634 [36.8]
Middle tertile	1639 [33.8]	360 [32.3]	351 [30.7]	565 [32.8]
High tertile	1744 [36.0]	377 [33.8]	365 [31.9]	524 [30.4]
Work status				
Working	2417 [49.8]	500 [44.9]	552 [48.2]	792 [45.9]
Not working	2436 [50.2]	614 [55.1]	593 [51.8]	932 [54.1]
Cognitive functioning				
Low tertile	1443 [29.8]	397 [35.7]	382 [33.4]	673 [39.1]
Middle tertile	1648 [34.0]	350 [31.5]	377 [33.0]	542 [31.5]
High tertile	1753 [36.2]	365 [32.8]	385 [33.7]	508 [29.5]
Physical symptoms W4				
No symptoms	1552 [33.2]	254 [24.1]	272 [24.9]	281 [17.0]
One or more symptoms	3116 [66.8]	802 [75.9]	819 [75.1]	1376 [83.0]
ADL W4				
No difficulties	4354 [89.7]	968 [86.9]	980 [85.6]	1381 [80.1]
One or more difficulties	499 [10.3]	146 [13.1]	165 [14.4]	343 [19.9]
Quality of life W4				
At or above median	2420 [51.2]	442 [40.8]	433 [39.1]	507 [30.4]

	No sleep disturbances *n* [%]	**Sleep disturbances at W1 only *n* [%]**	**Sleep disturbances at W2 only *n* [%]**	**Chronic sleep disturbances *n* [%]**
Below median	2305 [48.8]	642 [59.2]	674 [60.9]	1159 [69.6]

Note. Percentages refer to the ratio of variable categories within each of the sleep disturbance groups. $\chi^2(3) = 7.24$, $p = .07$, for geographical region; $\chi^2(6) = 7.52$, $p = .27$, for age; $\chi^2(3) = 370.84$, $p < .0001$, Cramer's $V = .21$, for gender; $\chi^2(6) = 59.90$, $p < .0001$, Cramer's $V = .06$, for education level; $\chi^2(3) = 52.19$, $p < .0001$, Cramer's $V = .08$, for marital status; $\chi^2(6) = 42.19$, $p < .0001$, Cramer's $V = .05$, for household income; $\chi^2(3) = 13.44$, $p < .01$, Cramer's $V = .04$, for work status; $\chi^2(6) = 58.03$, $p < .0001$, Cramer's $V = .06$, for cognitive functioning; $\chi^2(3) = 177.73$, $p < .0001$, Cramer's $V = .15$, for physical symptoms W4; $\chi^2(3) = 105.84$, $p < .0001$, Cramer's $V = .11$, for ADL W4; $\chi^2(3) = 238.98$, $p < .0001$, Cramer's $V = .17$, for quality of life W4.

Table 2

Logistic Regressions Predicting Physical Symptoms in Wave 4 by Sleep Disturbance

	Model 1 OR (CI)	Model 2 OR (CI)	Model 3 OR (CI)	Model 4 OR (CI)	Model 5 OR (CI)
Sleep disturbance (Reference: No disturbance)					
At W1 only	1.58 (1.35–1.84)^{c}	1.57 (1.34–1.84)^{c}	1.50 (1.28–1.76)^{c}	1.40 (1.19–1.64)^{c}	1.19 (1.00–1.41)^{a}
At W2 only	1.50 (1.28–1.74)^{c}	1.49 (1.28–1.74)^{c}	1.42 (1.21–1.66)^{c}	1.25 (1.07–1.46)^{b}	1.00 (0.84–1.18)
Chronic	2.42 (2.10–2.80)^{c}	2.42 (2.09–2.79)^{c}	2.19 (1.89–2.54)^{c}	1.79 (1.54–2.09)^{c}	1.31 (1.12–1.54)^{b}
Geographic region (Reference: Not Mediterranean)					
Mediterranean		1.16 (1.03–1.31)^{a}	0.95 (0.82–1.09)	0.81 (0.70–0.94)^{b}	0.83 (0.71–0.97)^{a}
Age (Reference: 50–59)					
60–69			1.06 (0.93–1.22)	1.08 (0.95–1.24)	1.06 (0.92–1.22)
70+			1.50 (1.27–1.78)^{c}	1.43 (1.21–1.70)^{c}	1.38 (1.15–1.66)^{c}
Gender (Reference: Men)					
Women			1.37 (1.23–1.52)^{c}	1.36 (1.23–1.52)^{c}	1.18 (1.05–1.32)^{b}
Education (Reference: Primary education or below)					
Lower to upper secondary education			0.82 (0.71–0.93)^{b}	0.84 (0.73–0.97)^{a}	0.86 (0.74–0.99)^{a}
Post-secondary education or above			0.76 (0.65–0.90)^{b}	0.80 (0.68–0.95)^{a}	0.89 (0.74–1.07)
Marital status (Reference: Not married)					
Married			0.92 (0.81–1.05)	0.97 (0.85–1.10)	0.96 (0.84–1.10)
Household income (Reference: Low tertile)					
Middle tertile			0.86 (0.76–0.98)^{a}	0.89 (0.78–1.02)	0.87 (0.75–1.00)
High tertile			0.85 (0.74–0.98)^{a}	0.91 (0.79–1.05)	0.90 (0.77–1.04)
Working status (Reference: Working)					
Not working			1.26 (1.10–1.43)^{b}	1.25 (1.09–1.43)^{b}	1.15 (1.00–1.33)^{a}
Cognitive functioning (Reference: Low tertile)					
Middle tertile			0.89 (0.77–1.02)	0.95 (0.83–1.10)	0.91 (0.78–1.06)
High tertile			0.82 (0.71–0.96)^{a}	0.90 (0.77–1.05)	0.84 (0.71–0.99)^{a}
ADL W1 (Reference: No difficulties)					

	Model 1 OR (CI)	Model 2 OR (CI)	Model 3 OR (CI)	Model 4 OR (CI)	Model 5 OR (CI)
One or more difficulties				2.54 (1.92–3.35)[c]	1.62 (1.21–2.16)[b]
Quality of life W2 (Reference: At or above median)					
Below median CASP				1.93 (1.73–2.15)[c]	1.51 (1.34–1.69)[c]
Physical symptoms W1 (Reference: No symptoms)					
One or more symptoms					2.47 (2.20–2.76)[c]
Physical symptoms W2 (Reference: No symptoms)					
One or more symptoms					3.06 (2.73–3.43)[c]
Nagelkerke R^2	0.03	0.05	0.07	0.10	0.24

Note. $N = 8249$. Table presents odds ratio (OR) and 95% confidence interval (CI) in parentheses. ADL = difficulties in activities of daily living. Model 1: unadjusted. Model 2: adjusted for geographic region. Model 3: adjusted for geographic region, background characteristics and cognitive functioning. Model 4: adjusted for geographic region, background characteristics, cognitive functioning and baseline of non-regressed outcomes. Model 5: adjusted for geographic region, background characteristics, cognitive functioning, baseline of non-regressed outcomes and W1 and W2 levels of regressed outcomes.

[a] $p < .05$

[b] $p < .01$

[c] $p < .0001$.

Table 3

Logistic Regressions Predicting ADL in Wave 4 by Sleep Disturbance

	Model 1 OR (CI)	Model 2 OR (CI)	Model 3 OR (CI)	Model 4 OR (CI)	Model 5 OR (CI)
Sleep disturbance (Reference: No disturbance)					
At W1 only	1.32 (1.07–1.61)^{b}	1.30 (1.06–1.60)^{b}	1.29 (1.04–1.59)^{a}	1.10 (0.88–1.36)	1.01 (0.88–1.28)
At W2 only	1.46 (1.20–1.77)^{c}	1.45 (1.20–1.77)^{c}	1.43 (1.17–1.76)^{c}	1.21 (0.98–1.49)	1.09 (0.87–1.36)
Chronic	2.16 (1.85–2.52)^{c}	2.16 (1.85–2.52)^{c}	2.03 (1.72–2.40)^{c}	1.57 (1.32–1.86)^{c}	1.33 (1.11–1.60)^{b}
Geographic region (Reference: Not Mediterranean)					
Mediterranean		1.25 (1.08–1.45)^{b}	0.94 (0.79–1.12)	0.81 (0.68–0.97)^{a}	0.87 (0.72–1.05)
Age (Reference: 50–59)					
60–69			1.63 (1.32–2.02)^{c}	1.68 (1.36–2.08)^{c}	1.63 (1.31–2.04)^{c}
70+			4.24 (3.41–5.27)^{c}	4.20 (3.37–5.24)^{c}	3.71 (2.94–4.69)^{c}
Gender (Reference: Men)					
Women			0.96 (0.82–1.11)	0.87 (0.74–1.01)	0.84 (0.72–0.99)^{a}
Education (Reference: Primary education or below)					
Lower to upper secondary education			0.97 (0.82–1.14)	1.00 (0.85–1.18)	1.03 (0.86–1.24)
Post-secondary education or above			0.73 (0.57–0.92)^{b}	0.75 (0.59–0.95)^{a}	0.80 (0.62–1.02)
Marital status (Reference: Not married)					
Married			0.63 (0.54–0.74)^{c}	0.66 (0.56–0.77)^{c}	0.67 (0.56–0.79)^{c}
Household income (Reference: Low tertile)					
Middle tertile			0.93 (0.78–1.10)	0.94 (0.79–1.12)	0.93 (0.78–1.12)
High tertile			0.99 (0.82–1.19)	1.04 (0.86–1.26)	1.05 (0.86–1.28)
Working status (Reference: Working)					
Not working			0.96 (0.80–1.13)	0.91 (0.76–1.08)	0.91 (0.76–1.09)
Cognitive functioning (Reference: Low tertile)					
Middle tertile			0.63 (0.53–0.74)^{c}	0.65 (0.55–0.77)^{c}	0.76 (0.63–0.91)^{b}
High tertile			0.56 (0.46–0.69)^{c}	0.59 (0.48–0.73)^{c}	0.68 (0.55–0.85)^{b}
Physical symptoms W1 (Reference: No symptoms)					
One or more symptoms				2.35 (1.97–2.80)^{c}	1.85 (1.54–2.22)^{c}

	Model 1 OR (CI)	Model 2 OR (CI)	Model 3 OR (CI)	Model 4 OR (CI)	Model 5 OR (CI)
Quality of life W2 (Reference: At or above median)					
Below median				1.90 (1.61–2.23)[c]	1.59 (1.34–1.88)[c]
ADL W1 (Reference: No difficulties)					
One or more difficulties					3.75 (3.05–4.60)[c]
ADL W2 (Reference: No difficulties)					
One or more difficulties					4.18 (3.44–5.09)[c]
Nagelkerke R^2	0.02	0.02	0.14	0.18	0.28

Note. N = 8600. Table presents odds ratio (OR) and 95% confidence interval (CI) in parentheses. ADL = difficulties in activities of daily living. Model 1: unadjusted. Model 2: adjusted for geographic region. Model 3: adjusted for geographic region, background characteristics and cognitive functioning. Model 4: adjusted for geographic region, background characteristics, cognitive functioning and baseline of non-regressed outcomes. Model 5: adjusted for geographic region, background characteristics, cognitive functioning, baseline of non-regressed outcomes and W1 and W2 levels of regressed outcomes.

[a] $p < .05$.

[b] $p < .01$.

[c] $p < .0001$.

Table 4

Logistic Regressions Predicting Quality of Life in Wave 4 by Sleep Disturbance

	Model 1 OR (CI)	Model 2 OR (CI)	Model 3 OR (CI)	Model 4 OR (CI)	Model 5 OR (CI)
Sleep disturbance (Reference: No disturbance)					
At W1 only	1.53 (1.33–1.75)^{c}	1.49 (1.30–1.72)^{c}	1.48 (1.28–1.71)^{c}	1.39 (1.20–1.61)^{c}	1.25 (1.07–1.46)^{b}
At W2 only	1.63 (1.42–1.87)^{c}	1.66 (1.44–1.91)^{c}	1.62 (1.40–1.87)^{c}	1.51 (1.31–1.75)^{c}	1.21 (1.03–1.41)^{a}
Chronic	2.36 (2.09–2.66)^{c}	2.44 (2.16–2.76)^{c}	2.31 (2.03–2.62)^{c}	2.04 (1.79–2.33)^{c}	1.53 (1.33–1.76)^{c}
Geographic region (Reference: Not Mediterranean)					
Mediterranean		4.10 (3.63–4.62)^{c}	3.19 (2.78–3.65)^{c}	3.23 (2.81–3.70)^{c}	2.47 (2.13–2.86)^{c}
Age (Reference: 50–59)					
60–69			0.95 (0.84–1.08)	0.95 (0.83–1.08)	0.99 (0.87–1.14)
70+			1.34 (1.15–1.57)^{c}	1.29 (1.11–1.51)^{b}	1.29 (1.09–1.52)^{b}
Gender (Reference: Men)					
Women			1.08 (0.98–1.19)	1.03 (0.94–1.14)	1.02 (0.92–1.14)
Education (Reference: Primary education or below)					
Lower to upper secondary education			0.86 (0.76–0.98)	0.87 (0.77–0.99)^{a}	0.92 (0.81–1.05)
Post-secondary education or above			0.76 (0.66–0.89)^{b}	0.79 (0.68–0.92)^{b}	0.83 (0.71–0.98)^{a}
Marital status (Reference: Not married)					
Married			0.95 (0.85–1.07)	0.97 (0.87–1.09)	1.09 (0.96–1.23)
Household income (Reference: Low tertile)					
Middle tertile			0.89 (0.79–1.00)	0.88 (0.78–1.00)	0.96 (0.84–1.10)
High tertile			0.74 (0.65–0.84)^{c}	0.74 (0.65–0.84)^{c}	0.84 (0.73–0.97)^{a}
Working status (Reference: Working)					
Not working			1.22 (1.08–1.38)^{b}	1.19 (1.05–1.35)^{b}	1.21 (1.06–1.38)^{b}
Cognitive functioning (Reference: Low tertile)					
Middle tertile			0.76 (0.67–0.86)^{c}	0.78 (0.68–0.88)^{c}	0.84 (0.73–0.97)^{a}
High tertile			0.69 (0.60–0.79)^{c}	0.70 (0.61–0.81)^{c}	0.77 (0.67–0.90)^{b}
Physical symptoms W1 (Reference: No symptoms)					
One or more symptoms				1.58 (1.43–1.74)^{c}	1.35 (1.21–1.50)^{c}

	Model 1 OR (CI)	Model 2 OR (CI)	Model 3 OR (CI)	Model 4 OR (CI)	Model 5 OR (CI)
ADL W1 (Reference: No difficulties)					
One or more difficulties				1.74 (1.42–2.14)[c]	1.59 (1.28–1.98)[c]
Quality of life W2 (Reference: At or above median)					
Below median					5.10 (4.60–5.65)[c]
Nagelkerke R^2	0.03	0.12	0.16	0.18	0.31

Note. N = 8383. Table presents odds ratio (OR) and 95% confidence interval (CI) in parentheses. ADL = difficulties in activities of daily living. Model 1: unadjusted. Model 2: adjusted for geographic region. Model 3: adjusted for geographic region, background characteristics and cognitive functioning. Model 4: adjusted for geographic region, background characteristics, cognitive functioning and baseline of non-regressed outcomes. Model 5: adjusted for geographic region, background characteristics, cognitive functioning, baseline of non-regressed outcomes and W1 and W2 levels of regressed outcomes.

[a] $p < .05$.

[b] $p < .01$.

[c] $p < .0001$.

Table 5

Logistic Regressions Predicting Outcomes in Wave 4 by Sleep Disturbance

	Physical symptoms OR (CI)	ADL OR (CI)	Low quality of life OR (CI)
Sleep disturbance (reference: At W2 only)			
None	1.00 (0.84–1.18)	0.87 (0.70–1.09)	0.82 (0.70–0.96)[a]
At W1 only	1.19 (0.96–1.49)	0.95 (0.72–1.25)	1.03 (0.84–1.26)
Chronic	1.32 (1.07–1.62)[b]	1.27 (1.00–1.61)[a]	1.26 (1.05–1.52)[a]

Note. Table presents odds ratio (OR) and 95% confidence interval (CI) in parentheses. ADL = difficulties in activities of daily living. Results are adjusted for geographic region, background characteristics, cognitive functioning, baseline of non-regressed outcomes and W1 and W2 levels of regressed outcomes

[a] $p < .05$.

[b] $p < .01$.

[c] $p < .0001$.