Sleep Medicine 10 (2009) S7–S11

Contents lists available at ScienceDirect

Sleep Medicine

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

Original Article

Sleep and its disorders in aging populations

Sonia Ancoli-Israel *

Department of Psychiatry, University of California, San Diego, CA, USA

ARTICLE INFO

Article history:
Available online 31 July 2009

Keywords:
Insomnia
Aging
Comorbidities
Circadian rhythms
Depression
Mortality
Falls

ABSTRACT

Most surveys confirm that older adults report sleeping about 7 h a night. While sleep architecture does change with age, most age-related sleep architecture changes occur in early and mid-years. Nevertheless, the incidence of insomnia is higher in older adults than younger adults, but is most often associated with other age-related conditions, rather than age *per se*. The consequences of poor sleep in older adults are substantial and include poor health, cognitive impairment and mortality. Sleep difficulties are significantly associated with medical and psychiatric comorbidities and the presence of multiple medical conditions has been found to be detrimental to sleep quality. Careful health assessment is necessary to screen out sleep complaints and disorders in older populations.

© 2009 Elsevier B.V. All rights reserved.

1. Introduction

Although many believe that with age, people sleep less, surveys examining sleep duration in different age groups have shown that, in general, older adults report sleeping around seven hours a night, an amount not very different from that reported by younger adults (Fig. 1) [1,2]. Although sleep architecture changes with age, nearly all age-related changes in architecture occur in early and middle age [3]. Slow-wave sleep (SWS) decreases dramatically from 16 years to approximately 35 years, but stabilizes from 60 years onward, as do most sleep parameters [3]. Only sleep efficiency (SE) continues to decline with age [3]. While controversy remains about the need for sleep changes with age, it is clear that the ability to sleep decreases with age [4,5].

This review will examine the various aspects of sleep in older adults and will discuss:

- insomnia in the elderly,
- consequences of poor sleep in older adults,
- the association between sleep symptoms and disease.

2. Insomnia in the elderly

Numerous studies have shown that the prevalence of insomnia is higher in older adults compared to younger adults [6,7]. A survey of 3161 non-institutionalized adults found that 25% of older adults (65–79 years), compared to 16% of 18- to 64-year-olds, suffered from insomnia [6]. Furthermore, in the Outcomes of Sleep Disorders in Older Men Study (MrOS Sleep Study; as part of the Osteoporotic Fractures in Men Study [MrOS]) [8], it was found that 44% of men aged $\geqslant$64 years, of which nearly one-third were 80 years or older, experienced poor sleep quality (Fig. 2a) [7].

An even higher prevalence of insomnia was reported in the Established Populations for Epidemiologic Studies of the Elderly (EPESE), a large observational community-based study conducted by the National Institute on Aging (NIA) involving more than 9000 patients. Chronic sleep complaints were found in over 50% of older adults (aged $\geqslant$ 65 years), particularly difficulty initiating or maintaining sleep (43%; Fig. 3) [9]. Similarly, in a study of older patients in 11 primary care practices ($n = 1503$; mean age 75.5 years), the most commonly reported sleep-related complaints were difficulty sleeping (45%), snoring (33.3%) and excessive sleepiness (27.1%) [10].

In older adults with insomnia, the rate of persistence of some insomnia symptoms is high. In a prospective, community-based epidemiological study of older adults ($n = 1050$; mean age 74.4 years) [11], difficulty falling asleep, sleep continuity disturbances, early morning awakening, and uncontrollable daytime somnolence were reported by 36.7%, 28.7%, 19.1% and 18.9% of individuals at entry to the study. At the 2-year follow-up, persistence was highest for difficulty falling asleep (74.9%), followed by sleep continuity disturbances (68.9%) and early morning awakening (47.3%). The proportion of patients reporting persistence in daytime somnolence was low (5.7%) but was significantly associated with mortality ($P < 0.05$) [11].

While these studies report high rates of insomnia, after adjustment for comorbidities, the prevalence of insomnia is very low in healthy older adults. It appears, therefore, that sleep problems

* Address: Department of Psychiatry, 9500 Gilman Drive 0733, La Jolla, CA 92093-0733, USA. Tel.: +1 858 822 7710; fax: +1 858 822 7712.
E-mail address: sancoliisrael@ucsd.edu

1389-9457/$ - see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.sleep.2009.07.004

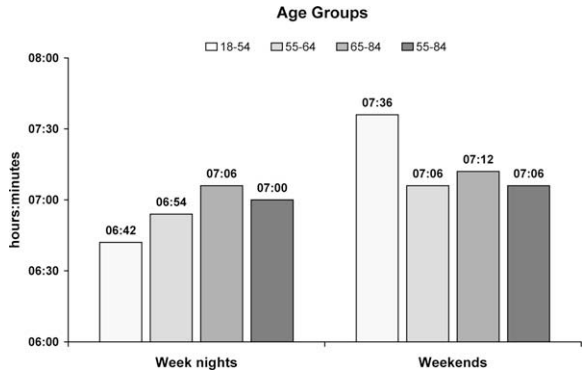

Fig. 1. Reported hours sleep by age in American adults [3].

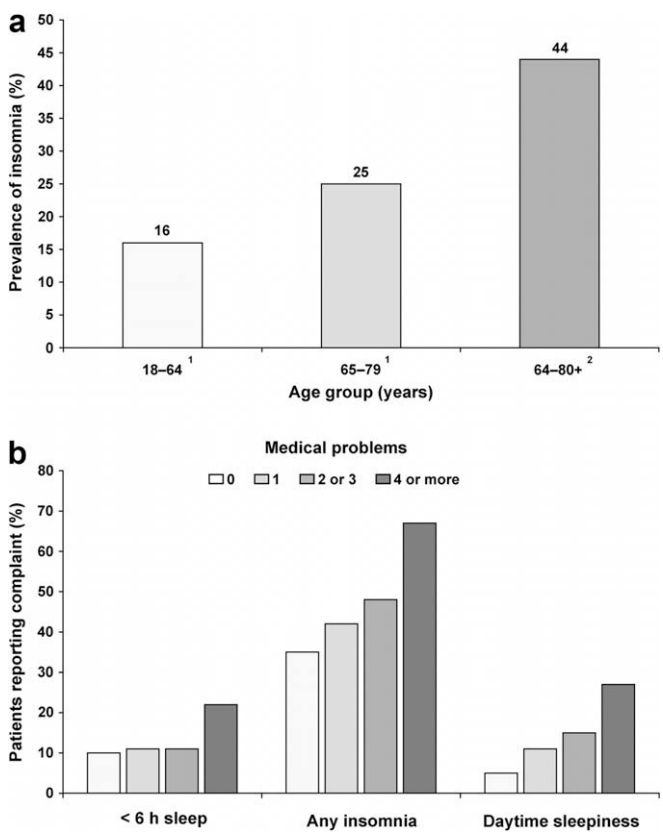

Fig. 2. (a) Insomnia prevalence by age group [6,7] (Insomnia defined as: [1]trouble falling asleep or staying asleep, $n = 3161$ [6]; [2]poor sleep quality on PSQI, $n = 3051$ [7]. PSQI = Pittsburgh Sleep Quality Index). (b) The association between sleep problems and medical conditions [14].

are associated with other age-related conditions, rather than age *per se* [12–14]. The EPESE study showed that incident insomnia in the elderly was primarily associated with depressed mood, respiratory symptoms, fair-to-poor perceived health, and physical disability; only 7% of incident insomnia occurred in the absence of associated risk factors [12]. At a 1-year follow-up, 50% of the older adults no longer had insomnia and the improvement was associated with improvements in health [12]. Another survey by Foley and colleagues also found that sleep complaints in older adults were often associated with their comorbidities rather than with age [14].

Vitiello and colleagues [13] screened 2954 elderly men and women to identify those with poor medical or psychiatric health.

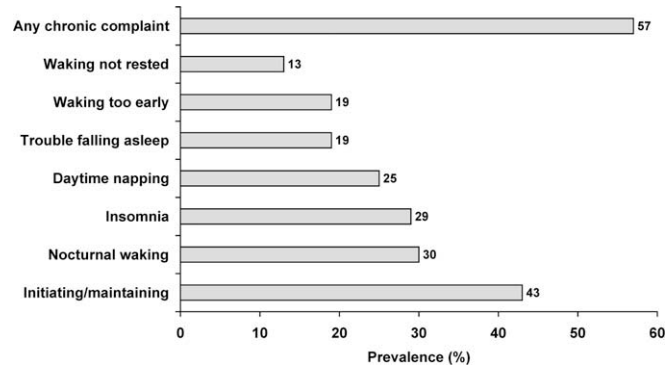

Fig. 3. Prevalence of sleep-related complaints in older adults ($\geqslant$65 years), $n = 9282$, mean age = 74 years [9].

Participants with sleep complaints were identified through volunteering a sleep complaint; direct questioning; or, if found to have good medical and psychiatric health with no subjectively identified sleep complaints, objective testing for insomnia based on measurements from polysomnography. Only 69 participants (2.34%) from the original community sample had a significant sleep complaint or a significant sleep disorder following polysomnographic evaluation. The authors concluded that when rigorous exclusion criteria for comorbidities are accounted for, the prevalence of insomnia is very low in healthy older adults [13].

These study results suggest that it is the medical and psychiatric illnesses, as well as the medications used to treat those illnesses, that are associated with insomnia [15]. There are also other factors affecting the ability to sleep in older adults including intake of alcohol, caffeine, and nicotine; circadian rhythm disturbances (delayed or advanced circadian rhythms); and primary sleep disorders, such as sleep-disordered breathing, restless legs syndrome and rapid eye movement behavior disorder [15,16].

Taken together, these studies support the notion that decrease in ability to sleep is associated not with age *per se*, but rather with all the factors associated with aging. It is, therefore, of utmost importance to make the correct medical and psychiatric diagnoses and treat these problems along with appropriate management of the underlying sleep disturbances in older adults.

3. Consequences of poor sleep in older adults

The consequences of poor sleep in older adults are substantial and include poor health, decreased physical function, falls, cognitive impairment, and mortality.

3.1. Poor health

Poor sleep at night has been associated with poor health in several studies. In the study of older patients in 11 primary care practices mentioned above, symptoms of poor sleep, including reports of daytime sleepiness, increased naps, feeling unrefreshed in the morning, and difficulty sleeping, were all found to be markers of poor physical and mental health (all significant at $P < 0.001$) [10]. In a large study of sleep habits of a community-dwelling French population ($n = 1026$) of older adults (60–101 years), poor sleep was associated with poor health as well as obesity. Specifically, short sleep duration of $\leqslant$4.5 h, late bedtime $\geqslant$1 a.m., early wake-up time $\leqslant$5 a.m. (all $P < 0.05$), and sleep-onset latency (SOL) $\geqslant$ 80 min (odds-ratio [OR] 3.6, 95% CI 1.8–7.3) were all associated with poor health. Short sleep duration $\leqslant$ 4.5 h ($P < 0.05$) was associated with obesity [2].

3.2. Physical function and falls

Poor physical function, and particularly falls, are of great concern in older populations. Several studies have examined the relationship between poor sleep and physical function and falls. In the large MrOS study described previously, sleep fragmentation and hypoxia were shown to be associated with poorer physical function in older men [17]. Polysomnography and wrist actigraphy measurements in 2862 elderly men (aged > 67 years) indicated that poor sleep at night, spending more than 90 min awake at night and sleep efficiency < 80% were all associated with lower grip strength, slower walking speed, inability to stand from a chair without assistance, and inability to complete a narrow walk course, after adjusting for age, body mass index, antidepressant use, hypertension, comorbid disease (history of at least one medical condition including cardiovascular disease, osteoarthritis, diabetes, COPD and Parkinson's disease), Physical Activity Scale for the Elderly, and smoking. The risks were all significant and ranged from odds-ratios of 1.3 (95% confidence interval [CI] 1.07–1.64) to 1.7 (95% CI 1.20–2.49) [17]. The authors concluded that disrupted sleep at night resulted in reduced physical performance.

Of even greater concern is the association of poor sleep and falls, after controlling for comorbidities and medication use, including benzodiazepine use. Avidan and colleagues [18] examined Minimum Data Set (MDS) data of 34,163 nursing home patients and found that untreated insomnia and hypnotic treated non-responsive insomnia were both associated with greater risk of falls (55% and 32% greater risk, respectively), while hypnotic use alone was not associated with greater risk of falls. In a cross sectional survey study in elder-hostels (n = 150) and older Internet users (n = 150) in Australia, it was reported that falls in the hostel group were associated with poor sleep quality (OR 4.5), number of nocturnal awakenings (OR 2.5), use of diuretics (OR 2.1) and pain and depressive symptoms. In the Internet group, falls were associated with poor health (OR 2.1), vision impairment (OR 2.3), use of glasses (OR 2.0) and use of walking aids (OR 4.4). It was noted that falls were not associated with use of benzodiazepines in either group [19]. Lastly, the association of poor sleep and falls was confirmed in the largest objective study to date, the Study of Osteoporotic Fractures (SOF). The SOF investigators collected a mean of 5-days of actigraphy data in over 3000 community-dwelling women aged 70 and older (mean age 84 years) who were followed for self-reported falls and fractures for 1 year. Information on falls was collected tri-annually by postcard with greater than 98% response rate. After adjustment for race, age, body mass index, medical conditions, depression, cognitive function, exercise, activities of daily living, antidepressant use, and benzodiazepine use, results showed an increased risk of falls with short sleep duration (TST < 7 h/night; OR 1.52; 95% CI 1.03–2.24) and fragmented sleep (SE ⩽ 65% (OR 1.36; 95% CI 1.07–1.74). Overall, there was a 30–40% increased risk of subsequent falls associated in older women with short sleep duration and poor sleep efficiency [20].

3.3. Cognitive impairment

Poor sleep has also been associated with cognitive impairment. In the study described above, Ohayon and Vecchierini found that short sleep duration < 6 h (P < 0.05) and daytime naps > 1 h (OR 1.7; 95% CI 1.1– 2.7) were both associated with cognitive impairment [2]. In another study, chronic symptoms of insomnia at both baseline and 3-year follow-up were demonstrated to be a significant and independent risk factor for cognitive decline in non-depressed men, but not in women. After adjustment for possible confounders, non-depressed men with chronic insomnia were 49% more likely to experience cognitive decline than those without insomnia (adjusted OR 1.49; 95% CI 1.03–2.14) [21]. Incident insomnia at the 3-year follow-up in non-depressed men was not associated with an increased risk of cognitive decline (OR 1.16; 95% CI 0.82–1.65) [21].

In the SOF study described above, objectively measured sleep parameters (5-day actigraphy) were consistently related to poorer cognition in older community-residing women (n = 2932; mean age 83.5 years). Compared with women with SE ⩾ 70%, those with SE < 70% had a higher risk of cognitive decline (MMSE < 26, OR 1.61, 95% CI 1.20–2.16; Trails B > 278, OR 1.96, 95% CI 1.43–2.67; both P < 0.05). In addition, longer sleep-onset latency (SOL) was associated with higher risk of cognitive impairment as was every 30 min increase in WASO (all P < 0.05) [22]. However, TST was not significantly associated with cognitive impairment. Overall, disturbed sleep was consistently related to poorer cognition which may suggest that it is disturbance of sleep rather than quantity of sleep that affects cognition in older women [22].

3.4. Mortality

Symptoms of poor sleep have also been found to be significantly associated with increased mortality. Electroencephalographic (EEG) sleep parameters (controlled for age, gender and baseline medical burden) were able to predict survival time in a moderately large cohort (n = 184) of community-dwelling older adults (mean age 74.5 years) followed for an average of 12.8 years. Sleep-onset latency (SOL) > 30 min increased the relative risk of death by 2.14 compared with SOL ⩽ 30 min (P = 0.005; 95% CI 1.25–3.66), whereas SE < 80% increased the relative risk of mortality by 1.93 compared with SE ⩾ 80% (P = 0.014; 95% CI 1.14–3.25) [23].

An increased risk of mortality has also been demonstrated in older women. Women in the SOF study with TST ⩽ 4 or > 8 h per night had a 26%–27% increase in risk of mortality (relative risk = 2.7 [95% CI 1.3–5.7] and 2.6 [95% CI 1.0–6.6], respectively), while a 21% increase in risk of mortality was found for every 10% decrease in SE (RR = 1.21, 95% CI 1.07–1.38) after adjustment for potential contributing factors, including the use of sleep medications [24]. This study concluded that older women with poor sleep quality are at significantly greater risk of mortality compared to those with normal sleep patterns.

These results suggest that studies are needed to examine whether treating sleep disturbances will result in less cognitive deterioration, decreased risk of falls and longer survival.

4. Association between specific sleep symptoms and disease

4.1. Medical disease

Sleep difficulties are significantly associated with medical and psychiatric comorbidities, including cardiac and pulmonary disease, depression and osteoarthritis. Data from the 2003 National Sleep Foundation's annual *Sleep in America* poll demonstrated that the incidence of TST < 6 h/night or any symptoms of insomnia were higher in patients with heart disease than in those without (OR 1.70 [95% CI 1.12–2.58] and 1.99 [95% CI 1.29–3.07], respectively) [14]. Similarly, pulmonary disease was associated with TST < 6 h/night (OR 1.65, 95% CI 1.05–2.58) and with daytime sleepiness (OR 1.81, 95% CI 1.10–2.99), while the incidence of daytime sleepiness was higher in patients with stroke than in those without (OR 2.20, 95% CI 1.16–4.34) [14].

Sleep disturbance has also been reported for older adults (n = 429; mean age 72 years) with knee osteoarthritis participating in the Observational Arthritis Study in Seniors (OASIS) prospective epidemiological study [25]. This study demonstrated that difficulty falling asleep, difficulty staying asleep and early morning awakening were reported at least weekly by 31%, 81% and 51% of partici-

pants, respectively. Poor sleep was also correlated with greater knee pain ($P < 0.05$), decreased self-rated health ($P < 0.001$), poor functional status ($P < 0.001$) and depressive symptoms ($P < 0.001$) [25].

Sleep quality also decreases with increasing number of medical conditions; the 2003 National Sleep Foundation Survey found that 41% of participants reporting $\geqslant 4$ medical conditions perceived their quality of sleep as fair-to-poor compared with 10% of participants with no medical conditions (Fig. 2b) [14].

4.2. Psychiatric disease

There have been many studies confirming that depression is associated with sleep disturbances. In the older adult, the incidence of insomnia symptoms and daytime sleepiness was higher compared to those with depression than those without depression (OR 2.44 [95% CI 1.59–3.73] and 2.19 [95% CI 1.36–3.55], respectively) [14]. More recently, Paudel and colleagues [7] demonstrated that in the MrOS study, older men with higher levels of depression had poorer sleep using both objective and subjective measures. This study of 3051 men measured subjective sleep quality over a one-month period using the Pittsburgh Sleep Quality Index (PSQI) and objective sleep quality using wrist actigraphy (mean duration 5.2 nights). Men with higher levels of depressive symptoms had lower SE, prolonged SOL, greater WASO and greater number of long-wake episodes measured objectively, while subjective measurements showed greater impairment in sleep quality and greater daytime sleepiness (all $P < 0.001$) [7]. In multivariable-adjusted models, men with some depressive symptoms (3–5 depressive symptoms) and those with depression (>6 depressive symptoms) had greater odds of SOL of $\geqslant 1$ h compared with normal men (0–2 depressive symptoms) (OR 1.40 [95% CI 1.03–1.90] and 1.68 [95% CI 1.08–2.61], respectively; both $P = 0.006$).

Similarly, a strong association between levels of depressive symptoms and subjective sleep disturbances were identified which were independent of potential confounding factors. The odds of reporting subjective measures of poor sleep quality were 2 times higher in men with some depressive symptoms compared with normal men (OR 2.06, 95% CI 1.67–2.55) and 3.7 times higher for depressed men compared with normal men (OR 3.68, 95% CI 2.54–5.33) (both $P < 0.001$) [7]. Together, these results suggest that depression in older men is associated with poor sleep.

4.3. Sleep and medications

The medications used to treat various underlying medical and psychiatric problems are also associated with poor sleep [15]. In particular, medications often prescribed to older adults, such as β-blockers, bronchodilators, corticosteroids, decongestants, diuretics, as well as other cardiovascular, neurologic, psychiatric, and gastrointestinal medications can all result or perpetuate sleep disturbances. Medications such as sedatives-hypnotics, antihistamines, antidepressants (amitriptyline, doxepin, trazodone and mirtazapine), and dopamine agonists can all contribute to excessive daytime sleepiness which could potentially contribute to sleep-onset insomnia or exacerbate/maintain existing sleep problems. Polypharmacy and prescriptions of sedative drugs are increasingly prevalent among older adults, often without consideration of its effect on the patient's sleep. Whenever feasible, sedating medications should be administered prior to bedtime, while stimulating medications and diuretics should be taken during the day.

4.4. Changes in circadian rhythm with age

Circadian rhythms, the 24-h biological rhythms such as core body temperature and the sleep–wake cycle, are controlled by an internal pacemaker located in the suprachiasmatic nucleus of the anterior hypothalamus. In the older adult, factors associated with aging are thought to contribute to the desynchronization of rhythms. The circadian pacemaker itself degenerates with age which results in less robust rhythms. With age there is also a gradual decrease in rhythm amplitude which likely contributes to less consistent periods of sleep–wake across the 24-h day. The endogenous secretion of melatonin at night is also reduced with age, which results in a weaker circadian rhythm.

The most common clinical consequence of changes in circadian network is an advance of the circadian rhythm. This advanced phase results in sleep and wake times that are several hours earlier than societal norms. Older adults, therefore, feel sleepy in the early evening and awaken in the very early morning hours. Sleep during these times is often normal, but out of sync with the environment.

5. Conclusion

While there is still a question about the change in need for sleep with age, there is no question that the ability to sleep does decrease. But the decreased ability to sleep is associated with comorbidities and not with age *per se*. Older adults have a difficult time obtaining the sleep they require. In the absence of comorbidities, there is little change in sleep characteristics. Other factors associated with aging, however, such as medical and psychiatric illness, medications, and circadian changes, do cause sleep problems. These findings indicate that careful health assessment will screen out most sleep complaints and disorders in the older population.

Disclosures

Consultant/Scientific Advisory Board for Ferring Pharmaceuticals, Inc., GlaxoSmithKline, Orphagen Pharmaceuticals, Pfizer, Respironics, sanofi-aventis, Sepracor, Inc., Schering-Plough, Teva (each less than $10,000).

Grants/contracts: NIH, Sepracor, Inc., Litebook, Inc. Supported by sanofi-avenis, Wolters Kluwer, NIA AG08415.

Acknowledgements

The author would like to thank Wolters Kluwer Health for providing editorial assistance. This assistance was supported by sanofi-aventis.

References

[1] National Sleep Foundation. Sleep in America Poll; 2003 [updated 2003 10 March; cited 2008 24 September]; Available from: http://www.kintera.org/atf/cf/{F6BF2668–A1B4–4FE8–8D1A–A5D39340D9CB}/2003Sleep-PollExecSumm.pdf.
[2] Ohayon MM, Vecchierini MF. Normative sleep data, cognitive function and daily living activities in older adults in the community. Sleep 2005;28(8):981–9.
[3] Ohayon MM, Carskadon MA, Guilleminault C, Vitiello MV. Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. Sleep 2004;27(7):1255–73.
[4] Ancoli-Israel S. Sleep problems in older adults: putting myths to bed. Geriatrics 1997;52(1):20–30.
[5] Ancoli-Israel S, Poceta JS, Stepnowsky C, Martin J, Gehrman P. Identification and treatment of sleep problems in the elderly. Sleep Med Rev 1997;1(1):3–17.
[6] Mellinger GD, Balter MB, Uhlenhuth EH. Insomnia and its treatment. Prevalence and correlates. Arch Gen Psychiatry 1985;42(3):225–32.
[7] Paudel ML, Taylor BC, Diem SJ, Stone KL, Ancoli-Israel S, Redline S, et al. Association between depressive symptoms and sleep disturbances in community-dwelling older men. J Am Geriatr Soc 2008;56(7):1228–35.
[8] Orwoll E, Blank JB, Barrett-Connor E, Cauley J, Cummings S, Ensrud K, et al. Design and baseline characteristics of the osteoporotic fractures in men (MrOS) study – a large observational study of the determinants of fracture in older men. Contemp Clin Trials 2005;26(5):569–85.

[9] Foley DJ, Monjan AA, Brown SL, Simonsick EM, Wallace RB, Blazer DG. Sleep complaints among elderly persons: an epidemiologic study of three communities. Sleep 1995;18(6):425–32.
[10] Reid KJ, Martinovich Z, Finkel S, Statsinger J, Golden R, Harter K, et al. Sleep: a marker of physical and mental health in the elderly. Am J Geriatr Psychiatry 2006;14(10):860–6.
[11] Ganguli M, Reynolds CF, Gilby JE. Prevalence and persistence of sleep complaints in a rural older community sample: the MoVIES project. J Am Geriatr Soc 1996;44(7):778–84.
[12] Foley DJ, Monjan A, Simonsick EM, Wallace RB, Blazer DG. Incidence and remission of insomnia among elderly adults: an epidemiologic study of 6,800 persons over three years. Sleep 1999;22(Suppl. 2):S366–72.
[13] Vitiello MV, Moe KE, Prinz PN. Sleep complaints cosegregate with illness in older adults: clinical research informed by and informing epidemiological studies of sleep. J Psychosom Res 2002;53(1):555–9.
[14] Foley D, Ancoli-Israel S, Britz P, Walsh J. Sleep disturbances and chronic disease in older adults: results of the 2003 National Sleep Foundation Sleep in America Survey. J Psychosom Res 2004;56(5):497–502.
[15] Cooke JR, Ancoli-Israel S. Sleep and its disorders in older adults. Psychiatr Clin North Am 2006;29(4):1077–93 [abstract x–xi].
[16] American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th ed. Washington, DC: American Psychiatric Association; 2000. p. 597–661.
[17] Dam TT, Ewing S, Ancoli-Israel S, Ensrud K, Redline S, Stone K. Association between sleep and physical function in older men: the osteoporotic fractures in men sleep study. J Am Geriatr Soc 2008;56(9):1665–73.
[18] Avidan AY, Fries BE, James ML, Szafara KL, Wright GT, Chervin RD. Insomnia and hypnotic use, recorded in the minimum data set, as predictors of falls and hip fractures in Michigan nursing homes. J Am Geriatr Soc 2005;53(6):955–62.
[19] Latimer Hill E, Cumming RG, Lewis R, Carrington S, Le Couteur DG. Sleep disturbances and falls in older people. J Gerontol A Biol Sci Med Sci 2007;62(1):62–6.
[20] Stone KL, Ancoli-Israel S, Blackwell T, Ensrud KE, Cauley JA, Redline S, et al. Actigraphy-measured sleep characteristics and risk of falls in older women. Arch Intern Med 2008;168(16):1768–75.
[21] Cricco M, Simonsick EM, Foley DJ. The impact of insomnia on cognitive functioning in older adults. J Am Geriatr Soc 2001;49(9):1185–9.
[22] Blackwell T, Yaffe K, Ancoli-Israel S, Schneider JL, Cauley JA, Hillier TA, et al. Poor sleep is associated with impaired cognitive function in older women: the study of osteoporotic fractures. J Gerontol A Biol Sci Med Sci 2006;61(4):405–10.
[23] Dew MA, Hoch CC, Buysse DJ, Monk TH, Begley AE, Houck PR, et al. Healthy older adults' sleep predicts all-cause mortality at 4 to 19 years of follow-up. Psychosom Med 2003;65(1):63–73.
[24] Stone KL, Blackwell T, Schneider JL, Ancoli-Israel S, Redline S, Cauley JA, et al. Impaired sleep increases the short-term risk of mortality in older women: preliminary results from a prospective actigraphy study. Sleep 2004;27(Suppl.):A123 [abstract 272].
[25] Wilcox S, Brenes GA, Levine D, Sevick MA, Shumaker SA, Craven T. Factors related to sleep disturbance in older adults experiencing knee pain or knee pain with radiographic evidence of knee osteoarthritis. J Am Geriatr Soc 2000;48(10):1241–51.