Sleep quality and recommended levels of physical activity in older people

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Minimum recommended levels of physical activity and sleep quality in older people.
ABSTRACT

The prevalence of insomnia symptoms increases with age, representing a major challenge to public health. While high levels of activity and exercise training have been associated with improvements in sleep quality across the lifespan, a minimum level of activity likely to improve sleep outcomes among older people has not been explored. This study investigated associations between walking at or above the internationally recommended threshold of ≥150 minutes per week and levels of insomnia symptoms and sleep quality in later life. Within a nationally representative UK sample aged 65+ (n = 926), cross-sectional regression models controlling for appropriate confounders showed that walking ≥150 minutes per week was significantly associated with a lower likelihood of reporting insomnia symptoms (OR = 0.67 (95% CI = 0.45 – 0.91) p<0.05), or reporting a lower sleep period percentage (of time in bed) (OR = 0.70 (95% CI = 0.52 – 0.94 p<0.05) at baseline. At 4 years follow-up (n=577), higher level at walking at baseline significantly predicted lower likelihood of problems getting to sleep (OR = 0.64 (95% CI = 0.42-0.97 p<0.05), and staying asleep (OR = 0.63 (95% CI = 0.41-0.95 p<0.05), but higher levels of walking did not significantly predict insomnia symptoms or sleep period percentage (OR = 0.70, N/S; and OR = 1.32, N/S).

The criterion validity of the activity measure was separately demonstrated in a controlled survival analysis, which showed a significantly decreased 27-year mortality hazard associated with the higher (≥150 minutes per week) walking level (HR =0.78 (95% CI = 0.68-0.84) p<0.01). These results are consistent with the conclusion that physical activity guidelines are sufficient to sustain sleep quality in older adults.
INTRODUCTION

Insomnia is most prevalent in later life (Sivertsen et al., 2009), independently increasing health risk (Baglioni et al., 2011), service utilisation (see Rosekind and Gregory, 2010), and economic burden (Daley et al., 2009; Rosekind and Gregory, 2010), and representing an international challenge to public health (Institute of Medicine, 2006; Stranges et al., 2014). While regular physical activity shows well established benefits in both the management of existing chronic disease (Leon et al., 2005; Colberg et al., 2010; Wipfli, Rethorst, & Landers, 2008), and the prevention of future ill health (Sattelmair et al., 2011; Jeon, Lokken, Hu, & Van Dam, 2007; Wolin, Yan, Colditz, & Lee, 2009), growing evidence suggests that the benefits of physical activity can also extend to sleep. Epidemiological studies, for example, have shown that lower levels of physical activity represent a significant risk for prevalent and incident insomnia symptoms (Janson et al., 2001; Morgan, 2003), and both laboratory studies and randomized controlled trials have shown that increased levels of physical activity are associated with improvements in sleep quality and structure (King et al., 1997; King et al., 2008; Driver & Taylor, 2000; Reid et al., 2010).

However, from a public health perspective, two important limitations can be identified in the present sleep-exercise literature. First, much of the experimental attention in older people has focussed on relatively high intensity activities (see Montgomery & Dennis, 2009; Yang, Ho, Chen, & Chien, 2012). Whether lower, more widely achievable, levels of activity may be sufficient to deliver sleep benefits to older people remains under-researched, with only relatively recent evidence on different doses of exercise on sleep quality (Kline et al., 2012). And second, where survey assessments of physical activity have been associated with sleep quality (Buman et al., 2013), such assessments are rarely accompanied by evidence of
health-related criterion validity for the activity measure (i.e. evidence that the assessed level of activity is significantly associated with health outcomes). The present analyses were designed to address both of these issues. In developing public health guidelines, systematic reviews have consistently found that moderate intensity physical activity levels at or above a threshold value of 150 minutes per week reliably deliver health benefits, mitigating risk factors for, and the impact of chronic diseases (Warburton et al, 2010). Although this overall weekly volume of engagement appears beneficial irrespective of the type of activity performed (Warburton et al, 2010), walking has been identified as the most convenient and achievable form of exercise for a high proportion of the adult population (Office of National Statistics, 2001). It remains unknown, however, whether a minimum of 150 minutes per week of walking is associated with improved sleep quality among older adults.

Using data from a longitudinal study of activity and health the principal aim of the present analyses was to assess cross-sectional and longitudinal relationships between currently recommended minimum activity levels and indices of subjective sleep quality. In order to evaluate the longer-term health relevance of the activity measure used, a secondary aim was to assess all-cause mortality within the activity groupings (i.e. those walking either above or below the threshold of 150 minutes/week) across the 27 year period 1985-2012. We hypothesise that, in comparisons of 2 survey groupings classified on the basis of reported walking activity, membership of the group walking at or above the recommended threshold (150 minutes/week) will be associated with significantly better sleep-related outcomes, and a significantly higher odds of 27 year survival.
METHODS

Data were derived from the Nottingham Longitudinal Study of Activity and Ageing (NLSAA), full details of which are presented elsewhere (Morgan, 1998). Briefly, the NLSAA is an ongoing study of health outcomes among people originally aged 65 and over living in the UK. The baseline survey for the NLSAA was conducted between May and September 1985, during which time 1042 people, randomly sampled from general practitioners' lists, were interviewed in their own homes. Subsequent analyses showed that the age, sex, and social class structure of the sample closely resembled that for England and Wales as a whole at the time of sampling (Morgan, 1998). A full follow-up survey was conducted in 1989, with an overall re-interview rate of 88% (n = 690) obtained among survivors. Information on mortality (date, time, location, and recorded cause of death) within the baseline sample was provided by the UK Medical Research Information Service, allowing for ongoing survival analyses. Assessments relevant to the present analyses are briefly described below.

Walking

Levels of customary physical activity likely to promote muscle strength, joint flexibility, or stamina were assessed using detailed activity inventories administered in the single face-to-face interview (for a full descriptive overview of the activity data at each survey wave, see Armstrong and Morgan, 1998). In the assessment of walking, the interviewer asked in detail about walking done on a typical day, selecting preferentially the day prior to interview. If, however, this day had been atypical, then another was selected (up to a maximum of six days previously). For the purposes of the interview, the selected day was divided into hours, and the amount of walking (purposeful walking, shopping, and recreational walking) in each hour was coded in
minutes, and finally expressed as minutes per typical day. These were then
aggregated in minutes per week.

Sleep
Subjectively estimated sleep quantity was assessed using the items: 1) “At what
time do you usually go to bed?”; 2) “At what time do you usually settle down in
bed to go to sleep?”; 3) How long does it normally take you to fall asleep?”; 4) “At
what time do you finally wake up?”; and 5) “At what time do you usually get up?”.
Responses were then used to estimate time in bed (TIB: time elapsed between
going to bed and getting up); sleep latency (SL: time taken to fall asleep); and
sleep period time (SPT: time from sleep onset to final awakening). An estimate of
“sleep period percentage” (SP%: the percentage of TIB occupied by the sleep
period) was then calculated as: SP% = (SPT/TIB) x 100). Since the present study
did not estimate intervening wakefulness during the sleep period, a formal
calculation of “total sleep time” (TST) was not possible. However, since
subjective SPT provides a significant analogue of TST (Van Der Kloet, 2013), it is
logical to assume that a lower SPE is indicative of less efficient sleep (where a
lower proportion of TIB is actually spent sleeping). Insomnia symptoms were
assessed using the item “Do you ever have problems sleeping (i.e. problems
getting to sleep and/or staying asleep and/or waking too early?)”, with five
response categories (never, seldom, sometimes, often, all the time). Positive
responses were followed with the question “Have you had this problem (or these
problems) in the past week?” Insomnia symptoms were considered present if the
respondent reported one or more sleep problem "often" or "all the time", and if
that problem had been experienced within the previous week. (While separately
reflecting subjective quantitative and qualitative estimates, SP% and insomnia
symptoms are not unrelated, since high proportions (>15%) of TIB spent awake typically indicate poor quality sleep, see Perlis, McCall, Jungquist, Pigeon, & Matteson, 2005).

Weight and Skeletal Size

At interview weight measurements (fully clothed with shoes removed) were made using calibrated analogue scales. To reduce error arising from kyphotic changes in measuring the height of older people, skeletal size was assessed using demispan (Bassey, 1986), the distance between the finger roots and the sternal notch (with the arm laterally outstretched). Body mass was then estimated using the Quetelet Index (BMI) based on weight and predicted height (Lehmann, Bassey, Morgan, & Dallosso, 1991). Those with a BMI >25 were judged to be overweight.

Physical Health Status

General health was assessed using a health index scored from zero (no health problems) to 13 (multiple health problems) covering the presence or absence of: heart, stomach, eyesight, or foot problems; giddiness, headaches, urinary incontinence, arthritis, falls, and chronic disease; drug and walking aid use, and recent (1 month) contact with (primary and secondary care) medical services. The scale showed full activity across its score range (0-13) and acceptable reliability (Cronbach’s alpha = 0.7).

Mental Health Status

Affective status was assessed using the separate anxiety and depression subscales from the Symptoms of Anxiety and Depression (SAD) Scale (Bedford, Foulds, & Sheffield, 1976) which focuses exclusively on recent symptoms.
Clinically significant levels of either anxiety or depression are indicated by subscale scores of ≥4. In validation trials conducted at baseline, scores at or above these cutpoints showed high levels of concordance with clinical diagnostic ratings (see Morgan, 1998).

Cognitive Function

At the beginning of the interview all respondents were initially screened for cognitive impairment using the 12-item Information/Orientation (I/O) scale from the Clifton Assessment Procedures for the Elderly (Pattie & Gillear, 1979). If, after appropriate prompting, the respondent failed to achieve a maximum I/O score of 8 and, in the opinion of the interviewer, was unlikely to respond reliably to the remaining questionnaire items, the interview was discontinued. In validation trials conducted at baseline, scores at or above this cutpoint showed high levels of concordance with clinical diagnostic ratings of dementia (kappa coefficient = 0.83, p<0.001; see Morgan, 1998).

Statistical analyses

Cross-sectional relationships between walking category (above/below the 150 minutes threshold) and subjective sleep variables at baseline were assessed in logistic regression models fitted separately for each sleep problem (present/absent), insomnia symptoms (present/absent) and sleep period percentage(<85%/≥85%). Longitudinal relationships between walking category (at baseline) and the presence/absence of sleep problems, sleep period percentage, and individual insomnia symptoms reported at 4-year follow up were also assessed in logistic regression models. All models were adjusted for
baseline: age (65-70; 70-74; 75-7; 80+); sex; physical health status (above and below median Health Index value); clinically significant levels of anxiety (yes/no) and depression (yes/no); BMI (≤25; >25) and social class (managerial/professional; skilled/semi-skilled; unskilled).

To assess the longer-term health relevance of the walking measure used, the relationship between walking category membership at baseline, and survival was assessed in a Cox regression model with survival (from baseline assessment in 1985 to death or censorship in March 2012) as dependent, and baseline: age (65-70; 70-74; 75-7; 80+); sex; physical health status (above and below median Health Index value); clinically significant levels of anxiety (yes/no) and depression (yes/no); BMI (≤25; >25) and social class (managerial/professional; skilled/semi-skilled; unskilled) as covariates. A forced entry approach to model selection was used. Initial examination of the log-minus-log plot of the survival functions showed no departure from the assumption of proportional hazards.

All data were analysed using SPSS for Windows v 20.0.

RESULTS

From the original baseline sample of 1042, information on both physical activity and subjective sleep quantity and quality was available from 926 respondents (with omissions due primarily to cognitive impairment or physical disability at baseline). At 4-year follow-up, information on subjective sleep variables was available from 577 survivors. Sample characteristics are shown in Table1. Overall, 49% of the sample reported sleep period percentages below 85%. The average sleep duration within the sample was 7h 8min, with a median duration of 7h 15min. Frequent (i.e. ‘often/all
the time’) problems getting to sleep, or staying asleep were the most frequently reported sleep difficulties (reported by 28% and 25% of respondents respectively), with early morning waking reported by 13%. Overall, 21.6% of the baseline sample met survey criteria for insomnia symptoms with women showing a significantly greater prevalence than men (Figure 1). The activity threshold of ≥150 walking minutes/week divided the sample at baseline into 37% above, and 63% below the recommended guidelines. The median weekly walking duration at baseline was 45 minutes/week.

Results from the logistic regression models examining relationships between walking levels and baseline sleep variables are shown in Table 2. The higher level of walking was significantly and independently associated with a lower likelihood of either reporting insomnia symptoms (OR = 0.67 (95% CI = 0.45 – 0.91) p<0.05), or a lower sleep period percentage (OR = 0.70 (95% CI = 0.52 – 0.94 p<0.05). In the logistic regression analyses of 4-year follow-up data, higher levels of walking (at baseline) did not significantly predict insomnia symptoms or sleep period percentage (OR = 0.70, and OR = 1.32, all non-significant respectively). We performed exploratory analyses on the individual insomnia symptoms, and we found that the higher level at walking at baseline significantly predicted a lower likelihood of problems getting to sleep (OR = 0.64 (95% CI = 0.42-0.97) p<0.05), and staying asleep (OR = 0.63 (95% CI = 0.41-0.95) p<0.05), but not early morning awakening (OR = 0.63, ns) four years later (Table 3).

In the 27-year period 1985-2012 the project received notification of 878 deaths within the sample of 926 participants included in this study. Results from Cox regression
analyses are shown in Table 4. The survival model showed that, after controlling for age, sex, and baseline measures of physical health, anxiety, depression, and social class, the higher level of walking was significantly associated with a decreased mortality hazard (HR = 0.78 (95% CI = 0.68-0.84) p<0.01).

**DISCUSSION**

Given the representativeness of the original NLSAA survey sample, and the relatively high response rates obtained at baseline, the present analyses offer a robust test of associations between moderate physical activity, at or above the recommended threshold value of 150 minutes/week, and insomnia symptoms prevalence, independent of concomitant health status at baseline. Several factors support the validity of the insomnia measure used in these analyses: the sleep problems audited in this survey reflect the cardinal symptoms of insomnia used in current nosologies (e.g. DSM V; American Psychiatric Association, 2013); analyses of baseline data (Morgan et al, 1988) showed a high degree of convergent validity among these sleep measures, with insomnia symptoms predicting shorter subjective sleep periods, longer subjective sleep latencies and lower sleep period percentages. Estimates of insomnia prevalence (Morgan et al, 1988) and incidence (Morgan and Clarke, 1997) using these measures fit comfortably within the range of internationally reported values from representative samples (see Morgan, 2012); and the classification of “insomnia symptoms” used in the present analyses accords with the criteria proposed by Ohayon (2002). Furthermore, that the survival analyses found a significantly lower mortality risk in those walking above the recommended threshold (independent of confounding health and demographic variables) offers support for the criterion of the walking measure used here, where walking over 150 minutes
(2.5 hours) a week was associated with increased survival at 27-year follow up, amounting to a 22% (0.78) decrease in hazard rate. The reduction in our analysis is consistent with that reported in other studies examining survival risks associated with physical activity generally (e.g., Hamer & Chida, 2009) or walking specifically (Samitz et al, 2011: 0.93 (0.87–0.97); Woodcock, Franco, Orsini, & Roberts, 2011: 0.89 (0.82-0.96)).

The overall pattern of the present findings indicates that even a relatively low intensity activity, such as walking to the level of the current guidelines, achievable by most older people, is associated with a significantly reduced likelihood of reporting sleep problems and insomnia symptoms, and significantly greater sleep period percentage. It would appear, then, that in general, older people who walked more, slept better. While the control variables used in the cross sectional analyses suggest that this association between higher activity and superior sleep quality is independent of mental and physical health factors, the possibility of inadequate statistical control, and reverse causality (where poorer sleep quality influences the capacity or motivation to walk) cannot be excluded. There are proposed reciprocal dynamic effects models between physical activity and sleep (Dzierzewski et al, 2014; Chennaoui et al, 2014), emphasising the potential to modify either of these behaviours to affect the other. However, the ability of baseline walking levels to predict the presence of sleep problems at the 4-year follow-up offers additional support for a conclusion that the present findings are consistent with a walking facilitated sleep benefit. Indicative of a dose-response relationship, the present results also show a more modest odds reduction than that shown when higher levels
of habitual physical activity are examined in relation to sleep outcomes (e.g. Hublin, Kaprio, Partinen, & Koskenvuo, 2001; Kim et al, 2009).

Though longitudinally predictive of individual sleep problems, levels of walking were not significantly related to insomnia symptoms at follow-up, suggesting a weakening of the relationship over time. It is relevant to note, however, that increasing morbidity and mortality within the sample, ontogenetic change in sleep variables, and changing social dynamics relevant to sleep (for example bereavement and the transition to sleeping alone), could all contribute to a shift in activity-sleep relationships. An adequate exploration of these and other factors is beyond the scope of the present paper, but now presents an important area for future research.

While there are established physiological mechanisms to account for the association between physical activity and survival (Taylor et al, 2004), there is less consensus on factors which may be mediating the effects of physical activity on sleep quantity and quality. Youngstedt (2005) has proposed that physical activity may alleviate sleeping difficulties through anxiety reduction, since anxiety is an independent risk factor for the onset of insomnia symptoms (Johnson, Roth, & Breslau, 2006). This view is supported both by evidence suggesting that acute and chronic exercise can lead to stable reductions in the manifestations of trait anxiety (O’Connor, Raglin, & Martinsen, 2000; Herring, O’Connor, & Dishman, 2010) and by the significance added to our own models by anxiety symptoms. A further possibility is that regular outdoor activity, independent of its intensity, increases exposure to light and, as a result, better maintains circadian entrainment (Gordjin, Beersma, Korte, & Van den Hoofdakker 1998; Youngstedt et al, 2003). This latter mechanism may be
particularly relevant to older people among whom levels of melatonin, the hormone which mediates the circadian rhythm’s entrainment to light, are known to decrease (Leger, Laudon & Zisapel, 2004). In an observational study of sleep quality and exercise Youngstedt et al (2003), found that the mean reported time spent outdoors was almost three times higher on days when participants were active, than on days when they were not active.

Only a small percentage of older people are functionally impaired to the extent of not being able to walk independently (Age UK, 2013). We acknowledge, however, the evident limitations of secondary analyses performed on data collected from an earlier generation of older people. Changes in physical activity and general health trends over the past 27 years, coupled with an increase in overweight/obesity trends could have introduced generational or cohort effects which impacted the key variables reported here. However, while these trends may have influenced the overall levels of walking in the contemporary older population aged 65+, it is less clear how secular change would impact relationships between walking and health and wellbeing outcomes. A further limitation of the present analyses concerns the assessment of sleep itself, which did not include a measure of intervening wakefulness (i.e. wakefulness during the sleep period). While this omission prevented the accurate estimation of sleep efficiency (where sleep efficiency = (SPT-wakefulness during sleep)/TIB x 100), the pattern of results reported here is consistent with the view that the SP% variable did provide a reasonable proxy for sleep efficiency. That the relationships identified in our study accord with contemporary findings, and can be accounted for by plausible biological mechanisms, also supports the validity of the conclusions drawn and, at the very least, offers 'proof of concept' that physical
activity-sleep relationships operate on a continuum even at relatively low intensity levels of activity.
*Figure 1. Prevalence of insomnia symptoms in each walking category at baseline (1985).

*Significant association between insomnia symptoms prevalence and gender: $X^2(1) = 19.29, p < 0.001.$
Table 1

Sample characteristics at baseline

<table>
<thead>
<tr>
<th>Baseline</th>
<th>&lt;150 min/week of PA</th>
<th>≥ 150 min/week of PA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total N: 926</td>
<td></td>
</tr>
<tr>
<td></td>
<td>580</td>
<td>346</td>
</tr>
<tr>
<td></td>
<td>n / %</td>
<td>n / %</td>
</tr>
<tr>
<td>Men</td>
<td>221 (38)</td>
<td>148 (43)</td>
</tr>
<tr>
<td>Women</td>
<td>360 (62)</td>
<td>197 (57)</td>
</tr>
<tr>
<td>Sleep period percentage below 85%</td>
<td>273 (47)</td>
<td>175 (51)</td>
</tr>
<tr>
<td>Insomnia symptoms*</td>
<td>146 (25)</td>
<td>56 (16)</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>167 (29)</td>
<td>92 (27)</td>
</tr>
<tr>
<td>Trouble maintaining sleep</td>
<td>163 (28)</td>
<td>68 (20)</td>
</tr>
<tr>
<td>Early morning awakening</td>
<td>74 (13)</td>
<td>48 (13)</td>
</tr>
</tbody>
</table>

4-year follow up

<table>
<thead>
<tr>
<th></th>
<th>Total N: 577</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>376</td>
<td>201</td>
</tr>
<tr>
<td></td>
<td>n / %</td>
<td>n / %</td>
</tr>
<tr>
<td>Men</td>
<td>131 (35)</td>
<td>104 (52)</td>
</tr>
<tr>
<td>Women</td>
<td>221 (65)</td>
<td>157 (48)</td>
</tr>
<tr>
<td>Sleep period percentage below 85%</td>
<td>180 (48)</td>
<td>98 (49)</td>
</tr>
<tr>
<td>Insomnia symptoms*</td>
<td>98 (26)</td>
<td>54 (27)</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>106 (28)</td>
<td>57 (28)</td>
</tr>
<tr>
<td>Trouble maintaining sleep</td>
<td>101 (27)</td>
<td>54 (27)</td>
</tr>
<tr>
<td>Early morning awakening</td>
<td>71 (19)</td>
<td>36 (18)</td>
</tr>
</tbody>
</table>

* Any of the three insomnia symptoms, reported frequency of ‘often’ or ‘all the time’, and experienced within the last week.
Table 2

Odds ratios and 95% confidence intervals for sleep variables in walking categories

<table>
<thead>
<tr>
<th>Models baseline*</th>
<th>B(SE)</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insomnia symptoms</strong>**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking category (lower)</td>
<td>-0.40(0.20)</td>
<td>0.67</td>
<td>0.45 – 0.91</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td><strong>Subjective sleep period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking category (lower)</td>
<td>-0.35(0.15)</td>
<td>0.70</td>
<td>0.52 – 0.94</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

*All models included covariates: physical health status, age, sex, depression, anxiety, social class and body mass index.

**Defined as the presence any of the three insomnia symptoms, reported frequency of often or all the time, and experienced within the last week.
Table 3

**Odds ratios and confidence intervals for the sleep variables in walking categories at 4-year follow up**

<table>
<thead>
<tr>
<th>Models 4-year follow up*</th>
<th>B(SE)</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Insomnia symptoms</em>**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking category (lower)</td>
<td>-0.35(0.21)</td>
<td>0.70</td>
<td>0.46 – 1.07</td>
<td>=0.10</td>
</tr>
<tr>
<td><em>Subjective sleep period percentage</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking category (lower)</td>
<td>-0.28(0.17)</td>
<td>1.32</td>
<td>0.93 – 1.87</td>
<td>=0.11</td>
</tr>
<tr>
<td><em>Separate insomnia symptoms presence</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problems getting to sleep</td>
<td>-0.43(0.21)</td>
<td>0.64</td>
<td>0.42 – 0.97</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Problems staying asleep</td>
<td>-0.45(0.21)</td>
<td>0.63</td>
<td>0.41 – 0.97</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Early morning awakening</td>
<td>-0.44(0.25)</td>
<td>0.63</td>
<td>0.39 – 1.04</td>
<td>=0.07</td>
</tr>
</tbody>
</table>

*All models included covariates: physical health status, age, sex, depression, anxiety, social class and body mass index.

**Defined as the presence any of the three insomnia symptoms, reported frequency of often or all the time, and experienced within the last week.
Hazard ratios and 95% confidence intervals for 27-year mortality (n=926; 5% survival rate)

<table>
<thead>
<tr>
<th>Model &amp; Variables</th>
<th>Hazard Ratio</th>
<th>95% CI</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking category (lower)</td>
<td>0.78</td>
<td>0.68 – 0.90</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Age b</td>
<td>1.41</td>
<td>1.15 – 1.73</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>0.70</td>
<td>0.62 – 0.81</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Physical Health Status (higher category)</td>
<td>1.30</td>
<td>1.11 – 1.51</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BMI</td>
<td>0.86</td>
<td>0.74 – 0.99</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Anxiety</td>
<td>1.12</td>
<td>0.90 – 1.41</td>
<td>=0.29</td>
</tr>
<tr>
<td>Depression</td>
<td>0.92</td>
<td>0.71 – 1.21</td>
<td>=0.58</td>
</tr>
<tr>
<td>Social Class (Class I &amp; II)</td>
<td>1.04</td>
<td>0.86 – 1.27</td>
<td>=0.63</td>
</tr>
</tbody>
</table>

* 2 tailed significance of regression coefficients.
† As 4 categories: 65-69;70-74;75-79;80+.
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