Sleep and Sleep Disorders in Older Persons

Sleep Disturbances and Falls in Older People

Elizabeth Latimer Hill,1 Robert G. Cumming,1 Ray Lewis,2 Susan Carrington,1 and David G. Le Couteur1,3,4

1Centre for Education and Research on Ageing, Concord RG Hospital and the University of Sydney, Australia.
2Greypath Pty Ltd, Melbourne, Australia.
3ANZAC Research Institute, Sydney, Australia.
4National Ageing Research Institute, Melbourne, Australia.

Background. Sleep disturbances are common in older people and may contribute to risk of falling.

Methods. Cross-sectional studies were performed in hostels and with an Internet-based survey. Questionnaires on falls and sleep disturbances were undertaken with clinical measures of cognition, mobility, blood pressure, and vision in the participants in hostels.

Results. There were 150 participants in hostels (mean age 81 ± 6 years) and 150 respondents to the Internet survey (mean age 70 ± 5 years). Sleep disturbances were reported by most participants in both the hostel and Internet studies. In hostel participants, falls were associated with poor sleep quality (odds ratio = 4.5, 95% confidence interval, 1.9-12.2; \( p = .002 \)) and number of nocturnal awakenings (2.5 ± 1.5 vs 2.0 ± 1.4, \( p = .04 \)). Other risk factors for falls in these persons included Geriatric Depression Scale score, pain, Timed Get Up and Go Test score, and the use of diuretics. In the Internet respondents, risk factors for falls included poor health rating and the use of spectacles, bifocals, and walking aids; fewer falls were reported by those participants without any sleep disturbances.

Conclusions. Sleep disturbances are common in older people and are associated with their risk of falling. Internet-based surveys may be a useful adjunct method for research in older people.

The majority of older people report sleep disturbances (1–6), and these disturbances are associated with cognitive and functional impairment (7–10). Thus it is plausible that sleep disturbances are a risk factor for falls, and indeed recent studies suggest such an association (11,12). It is well established that older people are at high risk of falls and fall-related injury (13–15), and many risk factors have been identified (13,16). Some of these risk factors are potentially modifiable, but to date only exercise, multidisciplinary interventions, and medication withdrawal have been shown in randomized trials to reduce the risk of falls (15,17). Because sleep disturbances are potentially remediable even in older people, for example, with sleep hygiene approaches (4), any association between sleep disturbances and falls might provide a new therapeutic target for falls prevention.

In this study, we hypothesized that sleep disturbances may contribute to an increased risk for falls. A cross-sectional design was used to study semi-independent persons in residential care, termed hostels. In addition, a novel approach to ageing research (specifically, an Internet-based survey) was trialed. Any conclusions about the association between sleep and falls are more strongly justified if similar results are obtained from two populations.

Furthermore, obtaining results in the Internet study similar to results obtained in hostels might indicate that Internet surveys are a useful adjunct for aging research. The use of the Internet for access to health information is widespread, although significantly less so in older people (18,19). In contrast, the use of the Internet as a survey tool for health research is still being developed. One recent study of drug knowledge indicated that the Internet was useful in collecting data from older people (20). Here, by obtaining epidemiological data from a more traditional source of participants (residential aged care facilities) and comparing the data with those obtained from the Internet survey, we aimed to determine the usefulness of Internet-based surveys for research in older age groups.

METHODS

Hostel Study Participants

The participants were 150 older people living in eight residential aged care facilities in metropolitan Sydney. They were recruited by advertising and through seminars. The facilities all provided hostel care (low level care) appropriate for semi-independent older people. Inclusion criteria included being at least 65 years old and having the ability to give consent. Exclusion criteria included cognitive impairment (Mini-Mental State Examination [MMSE] score < 20/30) and inability to speak English. The study had the approval of the Central Sydney Area Health Service Human Ethics Committee, and all participants provided written informed consent.

Data Collection in Hostel Participants

Demographic data, medical information, medications, and history of falls were determined by questionnaire. The
history of falls in the past 12 months was corroborated by examination of medical and nursing records maintained by the residential care facilities. A fall was defined as a sudden unintentional landing on the ground without preceding loss of consciousness (13).

Sleep characteristics were determined by questionnaire. Questions related to how long the person spent asleep, the restfulness of the sleep, whether they awoke feeling alert, whether they napped during the day and for how long, the quality of their sleep, and the number and nature of nighttime awakenings (21). Some patients were interviewed again between 6 and 12 months after the original interview to determine the kappa score for these questions. Daytime sleepiness was measured using the Epworth Sleepiness Scale (22).

Also assessed were the pain Visual Analogue Scale (VAS) (23), Barthel Index (24), Geriatric Depression Scale (25), MMSE (26), Snellen chart (27), and Timed Get Up and Go Test. The use of spectacles and walking aids was recorded. Lying and standing blood pressure (after 1 and 5 minutes standing) were measured.

This is a novel cohort of participants who have not been reported previously and who were studied for the purpose of examining the relationship between sleep disturbances and falls. All data collection was performed by E.L.H. and S.C.

Internet Study Participants
A 20-question survey was posted to the Greypath Web site (www.greypath.com.au). This site is an Australian-based Web site that provides a forum for older people and generates more than 1,000,000 hits each month.

The survey shared the same sleep questions as the hostel survey. In addition, questions were asked about demographic data, falls, injury, medication, daily exercise, and use of walking aids and spectacles. The answers could be selected from drop down menus in most cases. The falls question was identical to that used in the Hostel survey but could not be corroborated by medical records.

Statistical Analysis
We chose 150 responses on the basis of the study of Brassington and colleagues (11), in which, overall, the prevalence of various measures of poor sleep was about 10% in nonfallers and up to 25% in fallers. We assumed that about one third of the participants would be fallers. This generated a power of approximately 0.7 with \( \alpha = 0.05 \) for a chi-square test comparing two proportions. Univariate analysis of proportions was performed using the chi-square test, and means were compared with the Student t test. Results are presented as the mean ± standard deviation. Multiple logistic regression was used to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for associations between risk factors and a history of falls in the previous year (SigmaStat; SPSS Inc., Chicago, IL). Results were considered significant when \( p < .05 \).

RESULTS

Hostel Participant Characteristics
There were 150 participants with a mean age of 81 ± 8 years, and 66% were female. These participants were recruited from eight hostels and a pool of eligible residents of 398. The number of medical diagnoses per participant was 4.9 ± 2.0, and each participant was taking on average 6.1 ± 3.5 different medications per day. The mean MMSE score was 26 ± 3 and Barthel Index score was 97 ± 4.

Internet Survey Responses
Responses were received electronically over a period of 6 months, and the bulk (\( n = 120 \)) of the 150 responses were received within 3 months. There were 29 (19%) responses that were submitted between 10 PM and 8 AM. The majority of responses were from Australia, with 18 from other countries (9 from the United States, 4 from Canada, 2 from New Zealand, and 1 each from Costa Rica, Sweden, and Singapore).

Internet Respondent Characteristics
There were 150 respondents with an average age of 70 ± 5 years; 85 (57%) were female. The self-rated health was fair, poor, or frail in 36 participants (24%). Antihypertensive medications were taken by 75 participants (50%), sedative medications by 31 participants (21%), and antidepressants by 30 participants (20%). There were 59 participants who walked at least 1 hour every day.

Fifty-one participants (34%) reported visual impairment, which included cataracts (23 participants), glaucoma (9 participants), and the use of spectacles (139 participants, including bifocals in 82 participants).

Falls and Risk Factors for Falls in Hostel Participants
There were 66 participants (44%) who reported at least one fall in the preceding year; 36 of these participants (55%) had at least minor injury as a result of the fall. There were 30 participants (20%) with multiple falls. More falls occurred during the day (83%) than at night (17%).

The possible risk factors for falls that were investigated for an association with falls are shown in Table 1. The Timed Get Up and Go Test score, the Geriatric Depression Scale score, use of walking aids, and pain VAS score were all significantly associated with risk of falls. The Snellen chart score and use of diuretics came close to significance.

Falls and Risk Factors for Falls in Internet Respondents
There were 62 participants (41%) who reported falls in the previous year, of whom 24 had multiple falls (16%) and 42 recorded injuries as a result of the falls. Although most injuries were minor (such as bruises and grazes), there were eight reports of fractures.

Self-rated health, self-reported visual impairment, use of bifocals, and use of a walking aid were all statistically significantly associated with falls (Table 2). There was no association between falls and medications.

Sleep Disturbance
Sleep characteristics of hostel participants and Internet respondents are compared in Table 3. The kappa score was 0.8 (\( n = 85 \) participants reinterviewed 6–12 months after the first interview).

Among the hostel participants, the average Epworth Sleepiness Scale score was 4.0 ± 3.1 (out of 24), and there
Table 1. Risk Factors for a History of Falls in the Preceding Year in Hostel Participants

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Fallers N = 66</th>
<th>Nonfallers N = 84</th>
<th>Statistical Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>81.8 ± 8.4</td>
<td>80.1 ± 8.4</td>
<td>NS</td>
</tr>
<tr>
<td>Female gender</td>
<td>46 (70%)</td>
<td>53 (63%)</td>
<td>NS</td>
</tr>
<tr>
<td>MMSE score</td>
<td>26 ± 3</td>
<td>26 ± 3</td>
<td>NS</td>
</tr>
<tr>
<td>Geriatric Depression Scale score</td>
<td>5.1 ± 4.0</td>
<td>3.8 ± 3.3</td>
<td>( p = .035 )</td>
</tr>
<tr>
<td>Timed Get Up and Go score, s</td>
<td>29.7 ± 19.1</td>
<td>22.7 ± 13.0</td>
<td>( p = .008 )</td>
</tr>
<tr>
<td>Pain VAS score</td>
<td>3.3 ± 3.0</td>
<td>2.4 ± 2.6</td>
<td>( p = .054 )</td>
</tr>
<tr>
<td>Spectacles, No. of participants</td>
<td>24 (36%)</td>
<td>30 (36%)</td>
<td>NS</td>
</tr>
<tr>
<td>Snellen chart score</td>
<td>22 ± 20/6</td>
<td>17 ± 13/6</td>
<td>( p = .058 )</td>
</tr>
<tr>
<td>Walking aid, No. of participants</td>
<td>47 (71%)</td>
<td>48 (57%)</td>
<td>OR = 2.0, 95% CI, 1.5–4.1, ( p = .04 )</td>
</tr>
</tbody>
</table>

Blood pressure, mmHg

\[ 147 ± 22 / 80 ± 18 \] \( p = .047 \) \( OR = 2.1, 95\% CI, 1.5–4.1 \)

Orthostatic hypotension at 1 min, No. of participants

\[ 12 (18\%) \] \( p = .047 \) \( OR = 2.1, 95\% CI, 1.0–4.4 \)

Orthostatic hypotension at 5 min, No. of participants

\[ 6 (9\%) \] \( p = .047 \) \( OR = 2.1, 95\% CI, 1.0–4.4 \)

No. of diagnoses

\[ 5.0 ± 1.9 \] \( p = .047 \) \( OR = 2.1, 95\% CI, 1.0–4.4 \)

No. of medications

\[ 6.1 ± 3.2 \] \( p = .047 \) \( OR = 2.1, 95\% CI, 1.0–4.4 \)

Antipsychotics

\[ 14 (21\%) \] \( p = .047 \) \( OR = 2.1, 95\% CI, 1.0–4.4 \)

Diuretics

\[ 22 (33\%) \] \( p = .047 \) \( OR = 2.1, 95\% CI, 1.0–4.4 \)

Antidepressants

\[ 35 (53\%) \] \( p = .047 \) \( OR = 2.1, 95\% CI, 1.0–4.4 \)

Notes: Proportions were compared with chi-square test and continuous variables with Student’s t test.

NS = not significant; MMSE = Mini-Mental State Examination; VAS = Visual Analogue Scale; OR = odds ratio; CI = confidence interval.

Table 2. Risk Factors for Falls in the Internet Respondents

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Fallers N = 66</th>
<th>Nonfallers N = 84</th>
<th>Statistical Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (No. of Participants)</td>
<td>70 ± 5</td>
<td>70 ± 5</td>
<td>NS</td>
</tr>
<tr>
<td>Female (No. of Participants)</td>
<td>40 (65%)</td>
<td>45 (51%)</td>
<td>NS</td>
</tr>
<tr>
<td>Health rating (fair, poor, or frail)</td>
<td>20 (32%)</td>
<td>16 (18%)</td>
<td>OR = 2.1, 95% CI, 1.0–4.6, ( p = .047 )</td>
</tr>
<tr>
<td>Visual impairment (No. of Participants)</td>
<td>28 (45%)</td>
<td>23 (26%)</td>
<td>OR = 2.3, 95% CI, 1.2–4.6, ( p = .015 )</td>
</tr>
<tr>
<td>Bifocal spectacles (No. of Participants)</td>
<td>40 (65%)</td>
<td>42 (48%)</td>
<td>OR = 2.0, 95% CI, 1.0–3.9, ( p = .042 )</td>
</tr>
<tr>
<td>Walking aids (No. of Participants)</td>
<td>13 (21%)</td>
<td>5 (6%)</td>
<td>OR = 4.4, 95% CI, 1.5–13.0, ( p = .005 )</td>
</tr>
</tbody>
</table>

Notes: NS = not significant; OR = odds ratio; CI = confidence interval.

The characteristics associated with a risk of falling were poor self-reported sleep quality and nocturnal awakenings. There was no association with the amount of nighttime or daytime sleep or the Epworth Sleepiness Scale score. Furthermore, there was no association between the use of hypnotics and falls among those participants with poor sleep quality. Hypnotics were used by 41% of fallers with poor sleep quality versus 50% of nonfallers with poor sleep quality.

There was no association between falls and any specific measure of sleep disturbance in the Internet respondents. The participants who reported no sleep disturbance (n = 21, 14%) had a reduced risk of falling (OR = 0.3, 95% CI, 0.1–0.9; \( p = .04 \)).

Multiple logistic regression was performed with falls as the independent variable against age and those parameters found to be associated with falls on univariate analysis: Geriatric Depression Scale score, Timed Get Up and Go Test score, pain VAS score, Snellen chart score, use of walking aids, use of diuretics, awakenings, and poor sleep.

Table 3. Sleep Characteristics in Hostel Participants and Internet Respondents

<table>
<thead>
<tr>
<th>Sleep Characteristic</th>
<th>Hostel Participants N = 150</th>
<th>Internet Respondents N = 150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor or very poor sleep quality</td>
<td>23 (15%)</td>
<td>39 (26%)</td>
</tr>
<tr>
<td>Restless or very restless sleep</td>
<td>34 (23%)</td>
<td>43 (28%)</td>
</tr>
<tr>
<td>Awake drowsy or very drowsy</td>
<td>12 (8%)</td>
<td>22 (15%)</td>
</tr>
<tr>
<td>Fall asleep during day every day</td>
<td>66 (44%)</td>
<td>48 (32%)</td>
</tr>
<tr>
<td>No. of nocturnal awakenings</td>
<td>2.3 ± 1.5</td>
<td>1.9 ± 1.0</td>
</tr>
<tr>
<td>Awake 2 or more times at night</td>
<td>98 (65%)</td>
<td>84 (56%)</td>
</tr>
<tr>
<td>0 to &lt;4 hours sleep per night</td>
<td>9 (6%)</td>
<td>11 (7%)</td>
</tr>
<tr>
<td>4 to &lt;6 hours sleep per night</td>
<td>25 (17%)</td>
<td>50 (33%)</td>
</tr>
<tr>
<td>6 to &lt;8 hours sleep per night</td>
<td>75 (50%)</td>
<td>68 (44%)</td>
</tr>
<tr>
<td>8 to &lt;10 hours sleep per night</td>
<td>33 (22%)</td>
<td>19 (13%)</td>
</tr>
<tr>
<td>10 or more hours sleep per night</td>
<td>8 (5%)</td>
<td>2 (1%)</td>
</tr>
</tbody>
</table>

Notes: NS = not significant; OR = odds ratio; CI = confidence interval.
quality. Only poor sleep quality was statistically significant (OR = 3.2, 95% CI, 1.04–10.00; p = .04).

**DISCUSSION**

Falls were common during the previous year in both the hostel participants and the Internet respondents. In fact, the percentage of participants reporting falls was almost identical (44% vs 41%) as was the percentage recording multiple falls (20% vs 16%). Overall, it has been reported that the proportion of older people falling in a 1-year period varies from 28% to 35% in the 65-year-and-older age group, and this percentage increases to 32–42% in those persons older than 75 years (28). We have previously reported that, in residential care facilities in Australia, falls occur in 11% of residents (29) in a 1-month period and 42% in a 12-month period (14).

Likewise, sleep disturbances were common in both study groups. We found that approximately one in four hostel participants and Internet respondents reported sleep disturbances. The results match those published on other groups of older persons (5,6). In a study of over 9000 elderly persons, less than 20% reported no sleep disturbances (30). Similarly, we found that only 14% of hostel participants and 17% of Internet respondents reported no sleep disturbances (defined by sleep quality, restfulness, daytime sleeping, nighttime awakenings, and alertness on awakening).

Apart from the symptomatic effects, such a high rate of sleep disturbances in older people is a particular concern because of the clinically relevant daytime impairments. These impairments have been reported to include daytime sleepiness, difficulty in sustaining attention, slow response times, impairments in memory and concentration, and decreased performance (7–9). It has been proposed that such impairments might increase the risk of falls [especially the slowed response times (3)] in older people. In a telephone survey of 1526 older community-dwelling Americans, it was found that falls in the previous year were associated with difficulty falling asleep at night (OR = 2.06), waking up during the night (OR = 2.05), daytime sleepiness (OR = 2.40), or napping during the day (OR = 1.83) (11). More recently, in an analysis of a data set from 34,163 nursing home residents, it was found that insomnia predicted future falls (OR = 1.52); this finding appeared to be unrelated to concomitant use of hypnotics (12). Similarly, in our study of hostel residents we found that those participants who reported poor or very poor sleep quality had increased risk of falls (OR = 4.5) and as did participants with an increased propensity to nighttime awakenings. We did not find any such relationships in the Internet survey; however, in these respondents there was an inverse relationship between good sleep and falls (OR = 0.3). Although our numbers were small, we could not detect any apparent relationship between sleep disturbances, use of hypnotics, and falls. Thus now there is strong evidence that implicates sleep disturbances with falls in older people in a variety of settings including residential care and the community. We identified that the need to urinate, pain, noise, and thoughts were common contributors to the sleep disturbances. Simple strategies to reduce noise in the environment, improve analgesia treatment in persons with pain, and possibly to reduce nocturia might be valuable in improving sleep in older people, and hence reduce risk of falling.

Apart from sleep disturbances, our study also confirmed that poor vision (defined as the use of spectacles, bifocals, and the Snellen chart score) was a consistent risk factor for falls, confirming the marked association between falls and visual impairment noted in the Blue Mountains Eye Study (31). Poor mobility (defined by the Timed Get Up and Go Test and the use of walking aids) was also identified as a significant risk factor for falling. However, as we have previously reported (14), there does not appear to be any significant association between orthostatic hypotension and falls. It should be noted that some of the risk factors are collinear (e.g., use of mobility aids with the Timed Get Up and Go Test); therefore, there will be multiple associations with falls that are not independent, and it is difficult to prioritize and rank the factors. Furthermore, multiple risk factors were studied, which raises the likelihood of type I errors.

Our study also provides some support for the use of the Internet for research on older people. Our survey tool was placed on the Greypath Web site, which is a forum for older people that gets over 1,000,000 hits every month. Participants were invited to complete the survey, and the data were not identified. Within 6 months, there were 150 responses, with most of them completed within the first 3 months. Only two responses were discarded because the answers were nonsensical. The similarity in the responses of the Internet participants in terms of the prevalence of sleep disturbances and falls suggests that data derived from Internet

| Table 4. Association Between Sleep Characteristics and History of Falling in the Preceding Year in Hostel Participants |
|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| Risk Factor | Fallers | Nonfallers | Statistical Analysis |
|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| Poor or very poor sleep quality | 17 (26%) | 6 (7%) | OR = 4.5, 95% CI, 1.9–12.2, p = .002 |
| No. of nocturnal awakenings | 2.5 ± 1.5 | 2.0 ± 1.4 | p = .035 |
| Awake 2 or more times each night (No. of participants) | 51 (77%) | 47 (56%) | OR = 2.7, 95% CI, 1.3–5.5, p = .006 |
| Benzodiazepine sleeping tablets (No. of participants) | 11 (17%) | 16 (19%) | NS |
| Epworth Sleepiness Scale score | 4.0 ± 2.8 | 4.1 ± 3.3 | NS |
| 0 to <4 hours sleep per night | 5 (8%) | 4 (5%) | NS |
| 4 to <6 hours sleep per night | 11 (17%) | 14 (17%) | NS |
| 6 to <8 hours sleep per night | 29 (44%) | 46 (55%) | NS |
| 8 to <10 hours sleep per night | 16 (24%) | 17 (20%) | NS |
| 10 or more hours sleep per night | 5 (8%) | 3 (4%) | NS |

Notes: Proportions were compared with the chi-square test and continuous variables with Student’s t test. OR = odds ratio; CI = confidence interval; NS = not significant.
surveys might have broader generalizability. In addition, the Internet survey was able to identify some risk factors for falls similar to those in the hostel survey. Internet surveys have obvious limitations. It is not possible to perform physical measures such as visual acuity, blood pressure monitoring, gait analysis, and quality of respondent. From the epidemiological point of view, the main issues are the quality of respondents and sampling bias. The population of respondents may not reflect the general population of older, community-dwelling people. Patients older than 65 years were found to be less likely to report intended Web site use, even after adjusting for such factors as having a home computer, suggesting that older patients may be more resistant to nontraditional modes of receiving health information (18). This resistance is a barrier to surveys and to health information, particularly in the older age groups. The advantages, however, of an Internet survey is the speed at which data can be accumulated from a large number of individuals. This Web-based Internet study proved nevertheless to be an efficient method for collecting data. The short period for e-mail responses to the Web-based sleep survey yielded a higher return compared with the hostel survey method. Thus the Web-based survey has demonstrated a reliable and quick method of achieving health survey results.

Conclusion

Sleep disturbances were found to be common in both a hostel population of older people and among older Internet respondents. There was an association between sleep disturbances and falls in the hostel participants, and good sleep was inversely associated with falls among the Internet respondents. Improving sleep, perhaps through modifiable factors such as environmental noise and pain, might reduce the risk of falling. Internet-based surveys may prove to be a valuable research tool for the study of older people.

Acknowledgments

This study was supported by: Ageing and Alzheimers Research Foundation and Kay Worrall Scholarship in Geriatric Medicine; National Health and Medical Research Council (NHMRC) Injury Partnership: Prevention of Injuries in Older People; and www.greypath.com—Australian Seniors Internet Portal.

Mr. Ray Lewis runs the Greypath.com Web site utilized to collect data for the Internet survey. There are no other conflicts of interest to declare.

Address correspondence to David G. Le Couteur, MBBS, PhD, Center for Education and Research on Ageing (CERA), Concord Hospital, Sydney, NSW 2139, Australia. E-mail: dlecoutur@med.usyd.edu.au

References


Received February 19, 2006
Accepted April 21, 2006

Decision Editor: Darryl Wieland, PhD, MPH