

Do sleep problems or urinary incontinence predict falls in elderly women?

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The objectives of this cross-sectional study were: (1) To determine if night-time sleep disturbance, daytime sleepiness, or urinary incontinence were associated with an increased risk of falling in older Australian women and (2) to explore the interrelationships between daytime sleepiness, night-time sleep problems, and urge incontinence. Participants were 782 ambulatory, community-dwelling women aged 75 to 86 recruited from within the existing Calcium Intake Fracture Outcome Study, in which women above 70 years were selected at random from the electoral roll. Daytime sleepiness, night-time sleep problems, urinary incontinence and falls data were collected via self-complete questionnaires. Thirty-five per cent of participants had fallen at least once in the past 12 months and 37.7% reported at least one night-time sleep problem. However, only 8.1% of the study sample experienced abnormal daytime sleepiness (Epworth Sleepiness Scale score > 10). Pure stress, pure urge, and mixed incontinence occurred in 36.8%, 3.7%, and 32.6% of participants respectively. In forward stepwise multiple logistic regression analysis, urge incontinence (OR 1.76; 95% CI 1.29 to 2.41) and abnormal daytime sleepiness (OR 2.05; 95% CI 1.21 to 3.49) were significant independent risk factors for falling after controlling for other falls risk factors (age, central nervous system drugs, cardiovascular drugs). As urge incontinence and abnormal daytime sleepiness were independently associated with an increased falls risk, effective management of these problems may reduce the risk of falling in older women. [Teo JSH, Briffa NK, Devine A, Dhaliwal SS and Prince RL (2006): Do sleep problems or urinary incontinence predict falls in elderly women? *Australian Journal of Physiotherapy* 52: 19-24]

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Introduction

About one-third of the population above 65 years of age fall at least once a year (Dolinis et al 1997, Lord et al 1994, Tinetti et al 1988). The high prevalence of falls in the older population is of concern because of the substantial cost of falling to the individual and society. Much research has gone into the investigation of factors that could increase the risk of falling (Dolinis et al 1997, Graafmans et al 1996, Lord et al 1994, Tinetti et al 1988, Tromp et al 1998, Whooley et al 1999). There are various well established physiological (e.g. vision, balance and muscle strength) (Lord et al 1994) and environmental (Hill et al 2004) falls risk factors. There is some suggestion that other factors such as sleep problems (Brassington et al 2000) and urinary incontinence (Brown et al 2000, Tinetti et al 1988) are also associated with an increased risk of falls, however confirmatory findings of these observations are few.

Sleep problems are common in the ageing population (Ancoli-Israel 1997, Foley et al 1995). The aetiology of these sleep complaints relates both to the ageing process as well as to the presence of sleep disorders, changes in circadian rhythms, medical and psychiatric illnesses, medications, the use of alcohol and caffeine, and poor sleep habits (Ancoli-Israel 1997, Ancoli-Israel 2000).

Sleep deprivation has a negative impact on cognitive performance, motor performance and mood (Pilcher and Huffcutt 1996). Reaction times to different stimuli as well as attention and performance on cognitive tasks have been shown to deteriorate significantly in response to total sleep deprivation (Dawson and Reid 1997, Lorenzo et al

1995, Williamson and Feyer 2000). There is also evidence that sleep fragmentation (interrupted sleep) results in a reduction in daytime function and an increase in daytime sleepiness (Martin et al 1996, Whitney et al 1998). Many activities of daily living are complex motor and cognitive tasks that require the individual to process incoming visual, tactile, auditory and proprioceptive information, anticipate changes, and make quick adjustments to movement, posture and balance. It follows that reduced vigilance, attention, and information processing ability due to sleep deprivation or fragmentation could result in trips and falls.

Urinary incontinence has high prevalence in older women (Brown 2002), and negative clinical, psychological and social impact on the individual and the carers (Consensus development conference on urinary incontinence in adults 1989). Although the relationship between incontinence and falls has been documented in prospective studies (Moreland et al 2003), few of the prospective studies have examined the relationship in community-dwelling older women and only one has distinguished between urge and stress incontinence (Brown et al 2000). The symptoms of urge urinary incontinence, in particular, may predispose to a higher risk of falling as individuals with this condition experience an increased sense of urgency which necessitates them rushing to the toilet to avoid incontinent episodes.

Nocturia has been associated with stress urinary incontinence. As it is a symptom that requires the individual to arise from sleep to urinate (Nasr et al 1998) it was hypothesised that nocturia-disturbed sleep could result in sleep deprivation. The negative effects of sleep deprivation and fragmentation as discussed above could increase the falls risk in an older

individual. Nocturia may contribute to sleep disturbance or be a risk of falls in its own right.

The purpose of this study was to determine if night-time sleep disturbance, daytime sleepiness and urinary incontinence, in particular urge urinary incontinence, were associated with an increased risk of falling. The study also explored the interrelationships between night-time sleep problems, daytime sleepiness, and urge incontinence.

Method

This was a cross-sectional study within an ongoing cohort study. The potential subjects for this study were the 1500 women recruited to the existing Calcium Intake Fracture Outcome Study (CAIFOS), a 5-year prospective, randomised, controlled trial of oral calcium supplementation in the prevention of osteoporotic fractures. Volunteers for the CAIFOS study were recruited using a population-based approach that has been described in detail elsewhere (Bruce et al 2002, Devine et al 2004). As previously reported, the CAIFOS participants were similar in terms of disease burden and pharmaceutical consumption to whole populations of this age (Australian Institute of Health and Welfare 2002) but they were more likely to be from higher socioeconomic groups (Bruce et al 2002, Devine et al 2004). The proportion of participants who reported falling in the preceding year (35%) was comparable to the 32% (Tinetti et al 1988) and 39% (Lord et al 1994) reported by earlier prospective studies in community-dwelling people of comparable age.

CAIFOS participants are reviewed annually. Data for this study were collected from the 782 women, from both placebo and intervention groups, who attended for their 4-year follow-up visit between June and December 2002. No women who attended this visit declined to complete the questionnaires. At this time-point 164 (10.0%) women had withdrawn from the study for personal reasons (93), medical reasons (59) and investigator decision (2); 50 (3.3%) were deceased. All the questionnaires used in this study were self-complete but a research assistant was in attendance and able to clarify details if requested. The research assistant also checked the questionnaires after completion to ensure that all questions were answered. Written informed consent was obtained from each individual, and the present study was approved by the Human Rights Committee of the University of Western Australia and the Human Research Ethics Committee of Curtin University.

Sleep problems Daytime sleepiness was measured using the Epworth Sleepiness Scale (ESS) designed to measure the average sleep propensity in daily life by combining the sleep propensities in eight different situations (Johns 1994). The participants were asked to rate on a scale of 1–3 how likely they would be to ‘doze off’ or ‘fall asleep’ in each of the situations. Abnormal daytime sleepiness was determined by an ESS score greater than 10. The ESS has been shown to have good test-retest reliability (Pearson’s $r = 0.82$, $p < 0.001$) and a high level of internal consistency (Cronbach’s $\alpha = 0.88$, $p < 0.001$) (Johns 1992) and is sufficiently sensitive to detect changes in daytime sleepiness in people without pathology (Doherty et al 2003).

Aspects of night-time sleep problems investigated were: (1) trouble falling asleep at night, (2) trouble with waking up during the night, (3) trouble waking and getting up in the morning, and (4) trouble with waking up too early and not being able to fall asleep again. Participants rated how

often they experienced each of these problems on a scale of 1 (never) to 5 (always). Participants were categorised as having a night-time sleep problem if they scored 4 or 5 on the relevant night-time sleep question (Brassington et al 2000).

Urinary incontinence Urinary incontinence was assessed by questionnaire. Incontinence was classified in two ways. In the primary classification, respondents who never experienced urine leakage were classified as continent and those who lost urine involuntarily, regardless of amount and frequency of loss, were deemed to have incontinence. A secondary, less rigorous classification was also explored, whereby women with mild symptoms (i.e. women who lost only a few drops of urine, on rare occasions) were also classified as continent. The type of incontinence was determined using urge and stress scores calculated from the female urinary incontinence questionnaire (Ishiko et al 2000). This questionnaire has been shown to have high sensitivity of diagnosis for stress urinary incontinence (SI) (83.2%), urge urinary incontinence (URI) (86.2%), and mixed incontinence (61.0%) when compared with clinical examination, pad test, and urodynamic data (Ishiko et al 2000). As mixed incontinence includes symptoms of both stress and urge urinary incontinence, participants with mixed incontinence were classified as having both urge urinary incontinence and stress urinary incontinence for statistical analyses.

Falls and potential covariates Falls history was determined by questionnaire. The participants were asked whether they had fallen in the past 12 months and if so, whether they had fallen once or more than once. A fall included falling on the ground or at some other level, such as a chair (Brassington et al 2000). Body mass index (BMI; kg/m^2) was calculated from reported heights and body weights. Information on current use of medications that act on the central nervous system and medications for the treatment of cardiovascular disease that may cause hypotension was obtained.

Statistical analysis Differences between fallers and non-fallers were assessed using t-tests for continuous variables and chi-squared tests for proportions. Associations between each risk variable and the occurrence of falling were examined using univariate logistic regression analysis. Multiple logistic regression analyses were conducted to determine the association between falls and each sleep and incontinence variable, independent of other risk factors.

Univariate logistic regression was also used to investigate the association between night-time sleep disturbance and daytime sleepiness, nocturia (defined as waking more than once or many times to pass urine after falling asleep at night), and sleep problems as well as that between urge urinary incontinence and sleep problems.

Unless otherwise stated, data are presented as mean [standard deviation (SD)] or odds ratio [(OR); 95% Confidence Interval (CI)]. Statistical significance was inferred where two-tailed $p < 0.05$.

Results

The age of the women in the study ranged from 75 to 86 years with a mean (SD) of 79.1 years (SD 2.7). The mean BMI was $27.4 \text{ kg}/\text{m}^2$ (SD 4.5). Most women had experienced childbirth (90.6%). Twenty-six per cent of the women were taking drugs that act on the central nervous system (CNS)

Table 1. Population characteristics and the differences in prevalence of the sleep and incontinence variables between non-fallers and fallers. Data are means (SDs) unless otherwise indicated.

	Total	Non-fallers	Fallers
Subjects			
Number (%)	782	507 (64.8)	275 (35.2)
Age (years)*	79.1 (2.7)	78.9 (2.6)	79.5 (2.7)
Height (cm)	157.6 (5.9)	157.9 (5.9)	157.1 (5.9)
Weight (kg)	68.1 (12.1)	67.9 (11.7)	68.6 (12.7)
BMI (kg/m ²)	27.5 (4.5)	27.3 (4.4)	27.8 (4.9)
Abnormal daytime sleepiness (%)**	8.1	5.7	12.4
Night-time sleep disturbance			
Trouble falling asleep (%)	16.5	15.2	18.9
Trouble with waking during the night (%)	21.1	20.7	21.8
Trouble with waking and getting up in the morning (%)*	4.6	3.0	7.6
Trouble with waking too early and not being able to fall back asleep (%)*	18.9	16.2	24.0
Urinary incontinence			
Urge incontinence (%)†*	36.3	30.8	46.5
Stress incontinence (%)‡	69.4	69.0	70.2
Covariates			
CNS drug use (%)*	26.1	22.7	32.4
CVS drug use (%)*	65.6	63.1	70.2
Nocturia (%)	40.8	38.5	45.1

SD = standard deviation. BMI = body mass index. CNS = central nervous system. CVS = cardiovascular system. * $p < 0.05$ for comparison between non-fallers and fallers. #Epworth Sleepiness Scale score > 10 . †Urge incontinence group includes those with mixed incontinence ($n = 255$). ‡Stress incontinence group includes those with mixed incontinence ($n = 255$)

while 65.6% were taking one or more cardiovascular drugs that may cause hypotension.

Falls Of the 782 women, 35.2% fell at least once in the past 12 months. Of those who had fallen, 36.4% fell more than once. Participants who reported falling were older than the non-fallers (79.4 versus 78.9 years; $p = 0.005$).

Sleep problems and urinary incontinence Overall, sleep problems were not common in this population. Only 8.1% of the women experienced abnormal daytime sleepiness. The four night-time sleep problems were generally more common (Table 1), except for 'trouble with waking in the morning' (4.6%). The fallers had a significantly greater prevalence of abnormal daytime sleepiness, 'trouble with waking and getting up in the morning' and 'trouble with waking too early and not being able to fall asleep again' (Table 1). Abnormal daytime sleepiness was more than twice as likely in those with 'trouble with waking during the night' (OR 2.34; 95% CI 1.36 to 4.03).

Urinary incontinence was experienced by 73.1% of the women; 69.4% had symptoms of stress urinary incontinence (36.8% with pure stress urinary incontinence) and 36.3% had symptoms of urge urinary incontinence (3.7% with pure urge urinary incontinence). Of the cohort 32.6% had both stress urinary incontinence and stress urinary incontinence (i.e. mixed urinary incontinence). Urge urinary incontinence but not stress urinary incontinence was more common among fallers than non-fallers (Table 1). There was no difference in the number of night-time trips to the toilet between fallers

and non-fallers. Urge urinary incontinence was associated with all measured aspects of poor sleep (OR 2.01 to 3.74, $p < 0.001$ for the four night-time sleep variables and OR 2.20; 95% CI 1.31 to 3.70 for increased daytime sleepiness). Nocturia was significantly associated ($p \leq 0.005$) with all of the night-time sleep variables except 'trouble with waking and getting up in the morning'.

Factors associated with falls In univariate logistic regression analysis urge urinary incontinence, abnormal daytime sleepiness, 'trouble with waking and getting up in the morning', and 'trouble with waking too early and not being able to fall asleep again' were associated with falls status (yes/no) (Table 2). Potential covariates that were associated with falls included age, CNS drugs, and CVS drugs (Table 2).

When forward stepwise multiple logistic regression analysis was conducted including all the sleep and incontinence variables but without adjustment for covariates, urge urinary incontinence (OR 1.80; 95% CI 1.32 to 2.46), abnormal daytime sleepiness (OR 2.05; 95% CI 1.20 to 3.48), and 'trouble with waking and getting up in the morning' (OR 2.18; 95% CI 1.09 to 4.39) were significantly associated with an increased risk of falling. However, after adjusting for potential confounders by forcing age, CNS drugs, and CVS drugs into the model, only urge urinary incontinence (OR 1.76; 95% CI 1.29 to 2.41) and abnormal daytime sleepiness (OR 2.05; 95% CI 1.21 to 3.49) were independently associated with an increased falls risk.

Table 2. Association between falls and sleep, incontinence, and covariates.

Variables	OR	95% CI	<i>p</i>
Abnormal daytime sleepiness (y/n)#	2.33	1.38 to 3.91	0.001
Night-time sleep disturbance			
Trouble with falling asleep (y/n)	1.30	0.884 to 1.92	0.18
Trouble with waking during the night (y/n)	1.07	0.747 to 1.53	0.72
Trouble with waking and getting up in the morning (y/n)	2.71	1.37 to 5.35	0.004
Trouble with waking too early and not being able to fall asleep again (y/n)	1.64	1.14 to 2.36	0.008
Urinary Incontinence			
Urge incontinence* (y/n)	1.96	1.45 to 2.65	< 0.001
Stress incontinence† (y/n)	1.06	0.767 to 1.45	0.74
Covariates			
Age (years)	1.08	1.02 to 1.14	0.005
CNS modifying drugs (y/n)	1.63	1.18 to 2.26	0.003
CVS modifying drugs (y/n)	1.38	1.00 to 1.89	0.05
Nocturia (y/n)	1.31	0.976 to 1.77	0.07

CNS = central nervous system. CVS = cardiovascular system. OR = odds ratio, obtained from univariate logistic regression models. #Epworth Sleepiness Scale score > 10. *Urge incontinence group includes those with mixed incontinence (n = 255). †Stress incontinence group includes those with mixed incontinence (n = 255).

Reclassification of women with mild symptoms (i.e. women who lost only a few drops of urine, on rare occasions) as continent, reduced the prevalence of stress urinary incontinence and urge urinary incontinence to 42.3% and 30.7% respectively. This reclassification did not alter which factors were associated with falls in either the univariate or multivariate logistic regression analyses.

Discussion

Urge incontinence and abnormal daytime sleepiness were found to be independently associated with an increased risk of falling in these older community-dwelling women. Women with urge urinary incontinence were 1.76 times more likely to have a fall in the past year than those without. Women who experienced an abnormal level of daytime sleepiness had twice the risk of falling compared to women without this problem.

Sleep problems are common in older, community-dwelling women. More than a third of the women (37.7%) in this study reported at least one night-time sleep problem, a level comparable with a previous study using the same questionnaire (Brassington et al 2000). In contrast, the prevalence of daytime sleepiness in this study was more than double the level reported by Brassington (8.1% versus 3.6%). Differing definitions of daytime sleepiness probably account for this difference. The ESS defines daytime sleepiness as the average propensity to fall asleep in daily life under a variety of conditions, whereas Brassington et al (2000) assessed daytime sleepiness as a measure of alertness during the day. Moreover, the high sensitivity and specificity of the ESS may have facilitated identification of the association between abnormal daytime sleepiness and an increased risk of falling.

In contrast to Brassington et al (2000), who found all four night-time sleep problems to be associated with falls,

this study found no association between any of the night-time sleep problems and an increased risk of falling in these older women. Notable differences between the studies are the inclusion of males and the lower incidence of reported psychotropic medication use (4%) in the other study.

'Trouble with waking during the night' was associated with abnormal daytime sleepiness in this and other studies (Martin et al 1996, Whitney et al 1998). It has been suggested that fragmented sleep may be the cause of increased daytime sleepiness or decreased daytime functioning (Martin et al 1996, Whitney et al 1998). Comparing the prevalence of night-time sleep problems and abnormal daytime sleepiness, it appears that not all night-time sleep problems carry over into detectable abnormal daytime sleepiness. This suggests that night-time sleep problems alone do not increase the risk of falling. However, if night-time sleep problems lead to abnormal levels of daytime sleepiness and deterioration in daytime function, the risk of falling may increase. In this case, addressing the problem of interrupted sleep may reduce the negative effects of abnormal daytime sleepiness on function and thus, potentially reduce the risk of falling.

Though there appears to be a relationship between abnormal daytime sleepiness and falls, the mechanism by which abnormal daytime sleepiness increases falls risk is unknown. There is evidence that sleep deprivation and fragmentation affect mood, cognitive function and motor performance (Dawson and Reid 1997, Lorenzo et al 1995, Martin et al 1996, Williamson and Feyer 2000), but further research is required to determine if an abnormally high level of daytime sleepiness has a negative impact on proprioception, reaction times, balance, dual-tasking or other physiological factors which could increase falls risk in older people. The effect of treatment of sleep problems on falls risk also requires further investigation.

This study primarily classified women who lost only a few drops of urine on rare occasions as incontinent. Most other studies have only included women with an incontinence problem that they considered 'troublesome' or a 'social or hygiene problem' in their analysis (Hampel et al 1997, Nasr et al 1998). This could explain the higher prevalence rates for urinary incontinence in this study when compared to some other studies (Brown et al 2000, Hampel et al 1997, Maggi et al 2001, Merkelj 2001). Reclassification of women with mild symptoms as continent resulted in more comparable prevalence figures. More importantly, repeating the multiple logistic regression analysis using the reclassification did not alter the interpretation of the results obtained.

The results of this study support the findings of Brown et al (2000) who reported that the risk of falls and fractures increases in women with weekly or more frequent urge urinary incontinence. Others have reported a relationship between incontinence and falls but have not distinguished between stress urinary incontinence and urge urinary incontinence (Tinetti et al 1988, Tromp et al 1998). Despite its prevalence, as many as 75% of women who suffer from urge urinary incontinence fail to seek treatment for this problem (Hampel et al 1997) yet effective treatments are available (Nasr and Ouslander 1998, Sarkar and Ritch 2000). Therefore, it is important for medical and other health professionals involved in falls prevention in the geriatric population to screen for and treat urge urinary incontinence as part of a holistic management approach.

The problem of urge urinary incontinence may be compounded by extraneous factors such as reduced muscle strength and poor balance, which in themselves are risk factors for falls in older people (Lord et al 1994). Hence, health professionals who are specifically involved in treating urge urinary incontinence in older women should screen for a history of falls, as past history of falls is one of the major risk factors for a subsequent fall (Hill et al 2004). Assessment and treatment of other falls risk factors in women who have been identified by this screening process can then follow to reduce their risk of falling.

Even though a clear association between urge urinary incontinence and an increased risk of falling among older women exists, the mechanism of action needs further investigation. Studies have shown that with increasing age, performance of mobility tasks declines when attention is divided (Lundin-Olsson et al 1997, Lundin-Olsson et al 1998). Older adults were found to perform more poorly than younger adults in an obstacle avoidance task when the individual's attention was divided between stepping over an obstacle and a reaction-time task (Chen et al 1996). In the same way, when an individual with urge urinary incontinence experiences urgency (strong desire to void), attention is necessarily divided between preventing urine leakage and safe ambulation to the toilet, avoiding likely obstacles along the way. Greater attention given to the task of preventing an 'accident' may result in insufficient attention to obstacles and lead to trips and slips.

The results of this study showed urge urinary incontinence to have an association with all four night-time sleep problems as well as with daytime sleepiness, though it must be noted that abnormal daytime sleepiness was associated with falls independently of urge urinary incontinence. Therefore, another possible reason for the association of urge urinary incontinence with an increased falls risk could be the effect of urge urinary incontinence on night-time sleep quality and

daytime sleepiness. However this hypothesis is not fully supported by the results of this study. Further research, including investigation into possible reduction in prevalence of falls subsequent to treatment of urge urinary incontinence is suggested.

Nocturia was found to predict three of the four night-time sleep problems but had no association with abnormal daytime sleepiness. This result again suggests the weak relationship between night-time sleep problems and abnormal daytime sleepiness. Nocturia was not associated with an increased risk of falling in this population, which is in contrast to the study by Stewart et al (1992) who found nocturia to increase falls risk. This may be due to the lower prevalence (40.8% versus 88.9%) of nocturia in this population. Due to the retrospective nature of this study, the time of the fall was not investigated. If there had been a distinction made between night and daytime falls, an association between night falls and nocturia might have been found.

Despite the significant associations found between falls and abnormal daytime sleepiness and urge urinary incontinence, causal relationships cannot be assumed due to the cross-sectional, retrospective nature of the study. Falls data were collected retrospectively and may therefore incorporate some recall bias. Consequently the proportion of women reporting falls in the preceding 12 months may be a low estimate, nonetheless it was quite similar to data from prospective studies (Lord et al 1994, Tinetti et al 1988). Prospective studies would be required to confirm the results reported here. The results of this study are also limited to application within a relatively healthy, community-dwelling population of older women. We are unable to generalise these results to all older people whose health and sociodemographic status would vary considerably.

In summary, urge urinary incontinence and abnormal daytime sleepiness are reversible factors associated with increased risk of falling in older women. Almost all health professionals agree upon the multifactorial nature of falls risk. In order to reduce an individual's risk of falling, it is insufficient to treat any one risk factor alone. Therefore, the results of this study add to the current body of knowledge on falls risk in older women, and highlight two additional areas that health professionals may need to consider when trying to identify falls risk, prevent falls and consequently improve an individual's quality of life.

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