

Original Article

## Nocturia and disturbed sleep in the elderly

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### Abstract

**Background:** Nocturnal urination (nocturia) is such a commonplace occurrence in the lives of many older adults that it is frequently overlooked as a potential cause of sleep disturbance.

**Methods:** We examined the prevalence of nocturia and examined its role in self-reported insomnia and poor sleep quality in a survey of 1424 elderly individuals, ages 55–84. Data were derived from a 2003 National Sleep Foundation telephone poll conducted in a representative sample of the United States population who underwent a 20-min structured telephone interview. Nocturia was not a focus of the survey, but data collected relevant to this topic allowed examination of relevant associations with sleep.

**Results:** When inquired about in a checklist format, nocturia was listed as a self-perceived cause of nocturnal sleep “every night or almost every night” by 53% of the sample, which was over four times as frequently as the next most often cited cause of poor sleep, pain (12%). In multivariate logistic models, nocturia was an independent predictor both of self-reported insomnia (75% increased risk) and reduced sleep quality (71% increased risk), along with female gender and other medical and psychiatric conditions.

**Conclusions:** Nocturia is a frequently overlooked cause of poor sleep in the elderly and may warrant targeted interventions.

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**Keywords:** Aging; Health survey; Nocturia; Sleep initiation and maintenance disorders; Prostatism; Falls

### 1. Introduction

Nocturnal urination (nocturia) is a mundane event in the lives of many older adults. It is frequently overlooked as a potential cause of poor sleep both by elderly persons, who view the phenomenon as an inevitable consequence of growing old, and by researchers, who may minimize the importance of nocturnal awakenings because of nocturia [1–3]. Among the population, the phenomenon of nightly awakenings for bathroom trips

has become so commonplace that it can essentially be considered a cultural “norm” or expectation among older persons. Multiple, overlapping causes of frequent urination at night in the aged population have been described, including loss of bladder capacity, decreased glomerular filtration rate, and nocturnal polyuria from decreased arginine vasopressin, incipient diabetes, sleep-disordered breathing, congestive heart failure and/or diuretic use [4]. Gender-specific causes have also been identified, including benign prostatic hypertrophy in men and vaginal atrophy and resulting reduced sphincter control in women. Despite such elucidation of underlying mechanisms, the significance of nocturia for disturbed sleep remains unclear. This is particularly

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true when viewed in the context of other highly prevalent morbidities well-acknowledged to be associated with sleep disturbance (cf. chronic pain) [5]. In this report, we examined prevalence and correlates of nocturia with special emphasis on how this phenomenon was related to disturbed sleep in an elderly population.

## 2. Methods

Data were derived from the 2003 National Sleep Foundation's (NSF) annual Sleep in America Poll. This was a telephone-based, 20-min interview (full copy available on request) consisting of a random sample of phone numbers of United States households employing age (three groups) and gender (two groups) quota sampling by region, based on 2000 Bureau of Census data. The targeted sample was 1500 non-institutionalized, elderly participants between the ages of 55 and 84 inclusive. Interviews were conducted between September 17 and December 10, 2002. Nearly 80% of interviews were conducted on weekdays between 5:00 PM and 8:00 PM, Saturdays between 10:00 AM and 4:00 PM, and Sundays between 4:00 PM and 8:00 PM. When a household was reached, a query was made regarding whether an

individual between the ages of 55 and 84 inclusive resided in the household, and the individual of that age with the most recent birthday was identified as the targeted interview. Proxy responses were not allowed. Interview response rate was 26%, yielding 1506 interviews, of which 1424 (823 women, 601 men) had complete data for use in the current analyses. Questions employed in the current analyses are shown in the Appendix. Statistical analyses consisted of  $2 \times 2$  contingency tables to describe bivariate relationships and odds ratios between pairs of relevant variables. We performed logistic regressions predicting self-reported insomnia and poor sleep quality as related to various medical conditions.

## 3. Results

Table 1 shows the prevalence of the participants who incurred self-defined insomnia, poor sleep, and nocturia. Based on these results, we combined fair and poor sleep quality into a single category for low sleep quality and considered bathroom frequency of every night or almost every night as positive for nocturia. For all three questions in Table 1, "don't know" and individuals refusing to answer were dropped from these and all subsequent analyses. Bivariate analyses of these categories indicated that individuals with nocturia (i.e., every night or almost every night) were more likely to define themselves as having insomnia (22.5% for those with nocturia, 13.0% for those without nocturia,  $\chi^2 = 21.47$ ,  $p < .0001$ ) and more likely to report low sleep quality (27.3% for those with nocturia, 16.7% for those without nocturia,  $\chi^2 = 22.87$ ,  $p < .0001$ ).

Table 2 indicates the relative prevalence of the nine other items constituting self-reported causes of poor sleep in the participants. With the exception of physical pain, the proportion of the population reporting that a particular symptom or condition disturbed their sleep on an every night or almost every night basis was very low (4% or less). Even pain was reported by only 12% of the participants as disturbing sleep on this frequent a basis. When compared to the endorsement of nocturia

Table 1  
Prevalence of insomnia, poor sleep quality and nocturia

Question (response)	Prevalence (%)
<i>Insomnia</i>	
No	82.02
Yes	17.98
<i>Sleep quality</i>	
Poor	8.01
Fair	14.26
Good	34.90
Very good	32.51
Excellent	10.32
<i>Nocturia</i>	
Every night/almost every night	52.53
Few nights/week	11.87
Few nights/month	9.06
Rarely	15.45
Never	11.09

Table 2  
Prevalence (%) of other self-reported causes of disturbed sleep

	Every night/almost every night	Few nights/week	Few nights/month	Rarely	Never
Nighttime heartburn	2.18	3.73	6.82	21.45	65.82
Headache	1.05	2.04	4.22	23.61	69.08
Physical pain	11.64	6.98	10.65	26.94	43.79
Cough	2.46	3.09	4.50	30.15	59.80
Health concerns	2.61	2.33	4.94	30.60	59.52
Money problems	1.90	1.97	6.06	24.51	65.56
Family problems	1.83	3.46	8.04	31.66	55.01
Caregiving	3.33	5.38	11.61	29.75	49.93
Uncomfortable bed	1.41	1.41	1.98	16.81	78.39

Table 3  
Prevalence of medical conditions<sup>a</sup>

Condition	Prevalence (%)
Heart disease	13.83
Hypertension	42.84
Arthritis	20.37
Diabetes	14.26
Cancer	2.95
Stroke	2.32
Pulmonary disease	7.72
Depression	8.01
Osteoporosis	9.13
Memory problems	1.26
Enlarged prostate (men only)	9.15

<sup>a</sup> Defined as a positive response to “Have you ever been told by a doctor that you have...” and “Are you currently receiving treatment for...”.

(53%) these differences were striking and reiterated the commonplace nature of awakenings to void from sleep.

As would be expected in a population in this age range, medical conditions were highly prevalent (Table 3). These estimates are derived from self-reports and may be subject to error, although the fact that participants were required to indicate that a condition was both diagnosed and treated probably results in these figures being somewhat conservative. Univariate and multivariate models predicting both self-reported insomnia and poor sleep by gender, nocturia and these comorbid medical conditions are shown in Tables 4 and 5. Consistent with many other epidemiologic studies [5], being female, depression and conditions involving chronic pain were associated with disturbed sleep. In both of these models nocturia remained an independent predictor of poor sleep.

A final set of analyses was limited to men and incorporated prostatism. Men with a history of diagnosis and treatment for enlarged prostate were significantly more likely to report nocturia, relative to men without such

history (67.3% vs. 48.0%,  $\chi^2 = 7.44$ ,  $p < .01$ ). In multivariate models, nocturia continued to be predictive (Table 6), suggesting that ongoing treatments for presumed prostatic hypertrophy were unsuccessful in modifying nocturnal voiding and/or that the association of nocturnal voiding with sleep disturbance exceeded the importance of the diagnosis of prostatism per se.

#### 4. Discussion

Given the robustness of nocturia as a predictor of poor sleep in this population, it is indeed curious why many well-done epidemiologic studies have minimized or even ignored its potential causal role for disturbed sleep in the nocturnal lives of older persons (e.g., 1). Without imputing intent for this general omission, one could speculate regarding several bases for its occurrence. Even if elderly subjects readily acknowledge that nocturia may awaken them frequently at night, it could be contended that, because most individuals return to sleep easily after nocturnal voids, this phenomenon does not carry import as a cause of disturbed sleep. Because the NSF poll did not specifically inquire about difficulty in returning to sleep (nocturia was presented simply in checklist format along with other medical conditions), we cannot eliminate this possibility. However, several aspects of our analyses would argue against such an interpretation. First, it is clear that within the NSF data, both self-defined low sleep quality and self-defined insomnia are predicted by nighttime bathroom trips in multivariate models, implying that nocturnal voids indeed impact an individual's perception of their own sleep however it is to be defined. Second, although the survey did not ask specifically about whether individuals did or did not have difficulty returning to sleep after voiding, participants responded to the nocturia item on the checklist with vastly higher relative endorsement rates than other well-acknowledged causes of nocturnal

Table 4  
Prediction of self-reported insomnia

Variables	Univariate odds ratios	95% confidence intervals		Multivariate odds ratios	95% confidence intervals	
		Low	High		Low	High
		Heart disease	1.48		1.03	2.12
Hypertension	1.29	.99	1.70	1.03	.77	1.38
Arthritis	2.34	1.73	3.15	1.85	1.35	2.55
Diabetes	1.36	.95	1.96	1.16	.78	1.74
Cancer	1.25	.59	2.65	1.23	.56	2.74
Stroke	2.69	1.30	5.53	2.28	1.06	4.89
Lung disease	1.23	.76	1.98	.90	.54	1.51
Depression	3.26	2.17	4.88	2.49	1.61	3.87
Osteoporosis	1.95	1.30	2.94	1.23	.79	1.93
Memory problems	2.96	1.14	7.70	1.07	.36	3.20
Nocturia	1.94	1.46	2.57	1.75	1.31	2.35
Female gender	1.85	1.38	2.47	1.64	1.20	2.23

Table 5  
Prediction of self-reported poor sleep quality

Variables	Univariate odds ratios	95% confidence intervals		Multivariate odds ratios	95% confidence intervals	
		Low	High		Low	High
		Heart disease	1.56		1.11	2.18
Hypertension	1.18	.92	1.52	.97	.74	1.26
Arthritis	1.84	1.38	2.45	1.44	1.06	1.95
Diabetes	1.32	.94	1.85	1.15	.79	1.67
Cancer	.95	.45	2.01	.87	.40	1.93
Stroke	1.53	.72	3.26	1.18	.53	2.60
Lung disease	1.71	1.12	2.61	1.33	.85	2.08
Depression	3.18	2.14	4.71	2.56	1.68	3.90
Osteoporosis	2.15	1.47	3.15	1.52	1.01	2.30
Memory problems	2.84	1.11	7.26	1.07	.37	3.09
Nocturia	1.87	1.44	2.42	1.71	1.31	2.23
Female gender	1.58	1.22	2.05	1.35	1.02	1.79

Table 6  
Multivariate prediction (including prostatism) of insomnia and poor quality sleep in males ( $n = 601$ )

Variables	Outcome			
	Insomnia		Poor quality sleep	
	Odds ratios	95% confidence intervals	Odds ratios	95% confidence intervals
Heart disease	1.07	.55, 2.09	1.00	.55, 1.81
Hypertension	1.03	.61, 1.73	1.04	.66, 1.63
Arthritis	1.62	.86, 3.04	1.76	1.01, 3.06
Diabetes	.75	.38, 1.50	.94	.53, 1.69
Cancer	.93	.23, 3.76	.67	.18, 2.54
Stroke	3.08	1.01, 9.40	1.00	.29, 3.41
Lung disease	.57	.17, 1.96	1.87	.80, 4.38
Depression	3.58	1.51, 8.51	2.63	1.16, 5.97
Osteoporosis	7.71	1.45, 41.12	4.00	.78, 20.49
Memory problems	.58	.06, 5.90	.46	.05, 4.37
Prostatism	1.35	.61, 2.98	1.53	.76, 3.06
Nocturia	2.72	1.58, 4.67	1.67	1.07, 2.61

sleep disturbance, such as pain, heartburn, and caregiving duties, which were inquired about in an identical format. Valid identification of these better recognized causes of sleep disturbance does not typically consider the additional qualification of difficulty returning to sleep to be a relevant cause for sleep disturbance. It should be pointed out that the definition of nocturia suggested by the International Continence Society (ICS) [6] stipulates that the voiding episode must be both preceded by and followed by sleep, though it also does not include criteria regarding relative ease or difficulty returning to sleep.

Another explanation as to why researchers have failed to recognize nocturia as a major cause of disturbed sleep in the elderly may reflect a pervasive assumption that *nocturia episodes occur secondary to awakenings from other causes*. To paraphrase, an elderly individual may awaken from a variety of other causes that remain unknown to them, perceive the need to void, and then make a bathroom trip [7]. One study suggested that subjects could identify the

basis for their awakening in only 5% of awakenings [7]. Perhaps as a consequence, older persons may attribute their awakenings to the need to use the bathroom “after the fact” [7]. There is no shortage of factors that result in nocturnal awakenings in the elderly population. These may include age-dependent intrinsic lightening of sleep homeostatic processes [8,9], chronobiologic changes [10], higher susceptibility to arousal from sources such as noise and light [11,12], awakenings from primary medical conditions (e.g., osteoarthritis, gastroesophageal reflux) [13,14], or specific sleep disorders such as sleep apnea [15–17]. In this scenario, an older individual may awaken from one or more of these causes, perceive a full bladder, and then voluntarily elect to arise from bed and void. Nocturia may thus represent an outcome of sleep disturbance, rather than its cause. Observational data cannot fully address these issues of causality. The only conclusive way to examine such possibilities would be clinical trials in elderly populations that either: (a) manipulate bladder function and examine

sleep disturbance as an outcome or (b) manipulate sleep disturbance and examine nocturia (bathroom trips) as an outcome.

Surprisingly few existing studies have been performed addressing either of the aforementioned approaches. Regarding possibility (a), several trials of muscarinic antagonists and desmopressin including sizeable numbers of adults age 50 and above have reported longer duration of first sleep episode before first nocturnal void [18–21], reduced diary-defined number of awakenings [22] or global self-reported improvements in sleep [23–27], but at least one trial showed apparent worsening of sleep due to dry mouth from such medication [28]. Daytime behavioral interventions targeting nocturnal bladder control in incontinent geriatric patients have shown mixed results on nocturnal incontinence and do not assess sleep per se [29], though one nocturnal incontinence intervention noted fewer awakenings at night [12]. Even fewer studies have addressed possibility (b); however, decreased nocturia episodes and nocturnal urine production have been associated with successful treatment of sleep apnea with nasal continuous positive airway pressure [15,30,31]. Song and Ku [32] reported that concurrent use of zolpidem and an alpha-blocker resulted in a greater reduction in nocturia episodes than alpha blockade alone, whereas Sugaya et al. [33] showed that exercise, which presumably solidified nocturnal sleep, resulted in decreased nocturia episodes. Other than such studies involving a specific sleep disorder and specific modality of treatment, we are not aware of any sedative/hypnotic or behavioral intervention trials for primary or comorbid insomnia (out of many hundreds performed) that have used nocturnal voids as an outcome. Thus, clarification as to whether nocturia is a cause or effect of disturbed sleep by reference to a limited number of relevant clinical trials remains equivocal at present.

Apart from causal issues, a systematic review of other population-based studies mentioning nocturia provides remarkably consistent results in associations with disturbed sleep. First, there can be little doubt that the prevalence of nocturia increases substantially with age in both men and women. Brocklehurst et al. [34] appeared among the first to specifically inquire about nocturia, noting that about 45% of patients over the age of 65 in a general medical practice in England had two or more bathroom trips per night. These figures generally have been supported by more recent epidemiologically based studies. In a nationally representative sample of the United States population ( $n = 5204$ ), Coyne et al. [35] reported that two or more nocturnal voids occurred in about 25% of the 65–74 year old population and in about 35% of the population over the age of 75. Two or more voids per night were associated with lower total sleep times and higher scores of sleep complaints on the Medical Outcomes Study Sleep Questionnaire.

In a report of data derived from the NSF Poll predating the current work, Foley et al. [36] noted that nocturia (defined using the same item as employed in the current analyses) was associated with daytime napping. Asplund and Aberg [37] provided detailed data in a Swedish population that indicated that the number of nocturnal voids (none, one, two, three or more) showed graded levels of endorsement to questions regarding sleeping poorly at night, increased awakenings at night, difficulty returning to sleep and greater levels of daytime tiredness. In a later study with over 10,000 elderly participants, Asplund [38] noted that respondents with three or more nocturnal voids were more likely to have poor sleep, have cardiovascular disease and be diabetic. Rembratt et al. [39] reported that nocturia and poor sleep were related independently of other medical conditions that might be expected to result in nocturnal voiding, such as congestive heart failure, diabetes and diuretics. Middlekoop et al. [40] showed that nocturia was by far the most commonly cited reason (67.5%) for disturbed sleep maintenance in a study of over 1400 Dutch residents ages 50–93, with prevalence of the phenomenon increasing with age. Virtually identical prevalence figures were noted in an Italian cohort [41] where 73.3% of men and 57.8% of women reported that their nightly awakenings were caused by need to void, whereas no other cause (pain, gastrointestinal symptoms, rumination, anxiety) exceeded 10%. Figures of 77% (men) and 74% (women) were more recently reported in a Danish population [42]. Several recent studies using standard psychometric instruments such as the Pittsburgh Sleep Quality Index [43], Medical Outcomes Study Sleep Scale [44] and Nordic Sleep Questionnaire [45] also have shown associations with lower sleep quality. We emphasize that neither these nor any of the other studies that have mentioned nocturia [46–51] have employed the multivariate modeling that we have used here, which otherwise allows the relative role of nocturia for poor sleep to be better understood, particularly in the context of other risk factors for compromised sleep quality.

Every bed rise episode and bathroom trip represents a potential exposure for a fall. Urge incontinence regardless of time of day has been associated with falls [52–54], and several studies have shown that nocturia per se is also a risk factor for falls [55–57]. Stewart et al. [55] reported that individuals who voided two times a night incurred elevated fall risk (odds ratio = 1.84), which was even higher with three or more voids per night (odds ratio = 2.15) over an interval of five years, and Asplund [56] recently reported similar results indicating that three or more voids per night increased a risk for hip fracture by 80%. The majority of nocturnal falls occurred in conjunction with bathroom trips, relative to less than 20% of daytime falls [57]. These findings are compatible with other data suggesting that insomnia and sleep distur-

bance (without specific reference to nocturnal voiding) may also be a risk for falls in community-dwelling populations [58,59], even apart from medication use. In essence, being awake at night for any reason increases the exposure for falls by increasing the likelihood of bedrise episodes. These data raise the logical, but seemingly heretical, possibility that effective pharmacologic treatments for disturbed sleep and nocturia, counter to many studies suggesting adverse events associated with their use on a population-wide basis [60–62], could be associated with a reduction in falls if efficacy for a given patient on a given night was successful in keeping the person asleep and in bed. Such a possibility was recently suggested by a retrospective analysis of sleep disturbance in nursing homes using the Healthcare Financing Administration mandated Minimal Data Set from over 34,000 nursing home patients in the state of Michigan [63].

Limitations of the NSF survey involve the relatively low response rate (26%) and the nature of the polling process that generated the current data. Polls, by their very nature, involved quota filling, rather than sample weighing, which is then used to construct a demographically representative population sample. Within the limitations of age, geography and gender, these data may be considered roughly representative of the independently living population (ages 55–84) residing in the particular locales from which it sampled. However, the quota sampling procedure only approximates the population and cannot be considered to represent a true random probability sample. Certain other constraints must be acknowledged. The polling procedure did not employ quotas for race or ethnicity, thus, in all likelihood, it underrepresented selected racial groups. Given these constraints and the limited geographical regions sampled within the United States (Northeast, Southwest, Midwest, Far West), the data are probably best considered as roughly representative of non-minority elderly

individuals with land-line telephones residing in those regions. Individuals residing within institutions or facilities (e.g., nursing homes, assisted living facilities) were excluded perforce, unless that individual had a private telephone number. Medical diagnoses were defined via self-report and in some cases may have been quite imprecise and inaccurate, particularly as they relate to nocturia (e.g., prostatism) [64,65]. As mentioned previously, the NSF Poll did not specifically gather data related to difficulty falling back to sleep after nocturnal voiding trips, nor did the survey collect data on the number of nocturia episodes, a relevant point because several studies [35,37] demonstrated a near-linear increase in the likelihood of poor sleep in relation to the number of nocturnal voids. The definition of nocturia used in the Poll also differed from the definition established by the International Continence Society [6], which defined nocturia as awakening one or more times per night for the purpose of voiding with an intention to return to sleep, but did not otherwise specify criteria to define length of time to return to sleep or the quantity of sleep that would occur subsequent to such bathroom trips. Such issues might also be important in determining whether nocturia defined in this manner was related to lower sleep quality. Future surveys examining nocturia and disturbed sleep should examine such phenomena in greater detail.

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### Appendix. Items from the National Sleep Foundation poll used in the current analyses

Question number	Possible response categories
(7) <i>Would you consider yourself to be someone who suffers from or experiences symptoms of insomnia?</i>	Yes/no
(11) <i>On most nights, how would you rate the quality of your sleep?</i>	Poor/fair/good/very good/excellent
(21) <i>Have you ever been told by a doctor that you have any of the following medical conditions?</i>	
Heart disease	Yes/no
Hypertension or high blood pressure	Yes/no
Arthritis	Yes/no
Diabetes	Yes/no
Cancer	Yes/no
Stroke	Yes/no
Lung disease, such as asthma, chronic bronchitis, emphysema	Yes/no
Depression	Yes/no
Osteoporosis	Yes/no

(continued on next page)

## Appendix (continued)

Question number	Possible response categories
Memory problems or forgetfulness	Yes/no
Enlarged prostate (men only)	Yes/no
<i>(22) (For each condition answered “yes” in #21) are you currently receiving treatment for:</i>	
Heart disease	Yes/no
Hypertension or high blood pressure	Yes/no
Arthritis	Yes/no
Diabetes	Yes/no
Cancer	Yes/no
Stroke	Yes/no
Lung disease such as asthma, chronic bronchitis, emphysema	Yes/no
Depression	Yes/no
Osteoporosis	Yes/no
Memory problems or forgetfulness	Yes/no
Enlarged prostate (men only)	Yes/no
<i>(31) How often do the following symptoms disturb your sleep?</i>	
Nighttime Heartburn	Every night or almost every night/a few nights a week/a few nights a month/rarely/never
Headaches	Every night or almost every night/a few nights a week/a few nights a month/rarely/never
Physical pain or discomfort	Every night or almost every night/a few nights a week/a few nights a month/rarely/never
Coughing	Every night or almost every night/a few nights a week/a few nights a month/rarely/never
The need to get up to go to the bathroom	Every night or almost every night/a few nights a week/a few nights a month/rarely/never
<i>(32) How often do any of the following disrupt your sleep?</i>	
Health concerns	Every night or almost every night/a few nights a week/a few nights a month/rarely/never
Money or financial issues	Every night or almost every night/a few nights a week/a few nights a month/rarely/never
Family problems	Every night or almost every night/a few nights a week/a few nights a month/rarely/never
Thinking about caring for others	Every night or almost every night/a few nights a week/a few nights a month/rarely/never
An uncomfortable bed or mattress	Every night or almost every night/a few nights a week/a few nights a month/rarely/never

*Notes:* Question numbers refer to order of questions as presented in the interview. Questions number 21, 31 and 32 were asked in rotating checklist format, i.e., the order in which the items were asked was varied with every interview. “Don’t know” and refused responses were allowed but constituted 1% or less for every question with the exception of question number 7, which tallied 3%. A positive disease indication required a “yes” response to both questions 21 and 22 for that condition.

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