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Periodic Limb Movements in Sleep in Community-Dwelling Elderly

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Summary: The prevalence of periodic limb movements in sleep (PLMS) in a randomly selected elderly sample is reported. In San Diego, 427 elderly volunteers aged 65 yr and over were recorded in their homes. Forty-five percent had a myoclonus index, MI ≥5. Correlates of PLMS included dissatisfaction with sleep, sleeping alone and reported kicking at night. Although statistically significant, the strengths of the associations between interview variables and myoclonus indices were all small. No combination of demographic variables and symptoms allowed highly reliable prediction of PLMS. **Key Words:** PLMS—Aging—Prevalence—Sleep—Myoclonus.

Periodic limb movements in sleep (PLMS), also known as nocturnal myoclonus, is a disturbance in which people experience periodic leg jerks throughout much of the night. Symptoms include leg kicks, insomnia, motor restlessness, excessive daytime sleepiness and sometimes cold feet (1,2). The prevalence of PLMS in all adults has been estimated at 5–6% in normals (3), and up to 18% in sleep disorders clinic samples (1,4–6).

In a review of 441 patients seen at a sleep disorders center, Coleman et al. found that patients with PLMS were significantly older than those without PLMS (7). Coleman et al. (6,8) and Ancoli-Israel (9) have reported that PLMS becomes more severe with age. The true prevalence of PLMS in the elderly has not previously been determined. As summarized by Ancoli-Israel (10), the few studies examining elderly found prevalence rates ranging from 4 to 24% among patients of all ages with sleep complaints (8,11–13) and from 25 to 37% in healthy elderly men and women (14–17).

This study examined the following questions: 1) How prevalent are periodic limb movements in sleep (PLMS) among the elderly population? 2) Are symptoms characteristic of PLMS (e.g. daytime sleepiness, insomnia and reported leg kicks) sufficiently discriminatory to predict the presence of the disorder? To address these questions, we present final results of a large survey in which objective and subjective data were obtained from a randomly selected elderly sample.

METHODS

Subject selection. The study methodology is described further in the accompanying article (18). Briefly, by random digit dialing (19), subjects were selected to represent all socioeconomic levels (i.e. from high, middle and low income areas). A telephone interview was conducted with all people identified as 65 yr or older.

Each subject was asked to schedule a home interview. After giving written consent, each volunteer was administered the home interview and was asked to schedule a home sleep recording. Of the 1,865 persons at least 65 yr of age randomly identified, 427 volunteers (23%) completed all parts of the study including home sleep recordings.

Interviews. The home interview lasted about 1 hr and included 142 questions about sleep, daytime functioning, exercise, medical history, medication use, diet, alcohol and tobacco use, family sleep history and demographic information. Related to leg kicks, subjects were asked, "Do your legs often twitch or kick during

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TABLE 1. *Mean myoclonus indices for men and women*

	Mean	SD	Median	Range
MI ≥ 5[a]				
Men (n = 89)	34.5	44.1	22.3	5.1–271.1
Women (n = 100)	22.8	23.0	15.9	5.2–165.8
Total (n = 189)	28.3	35.0	16.5	5.1–271.1
MI < 5				
Men (n = 103)	1.6	1.6	1.2	0–4.9
Women (n = 128)	1.4	1.5	0.9	0–4.9
Total (n = 231)	1.5	1.5	1.0	0–4.9
Total group[a]				
Men (n = 192)	16.9	34.2	4.3	0–271.1
Women (n = 228)	10.8	18.6	3.7	0–165.8
Total (n = 420)	13.6	27.0	4.1	0–271.1

[a] Significant difference between men and women (p = 0.02).

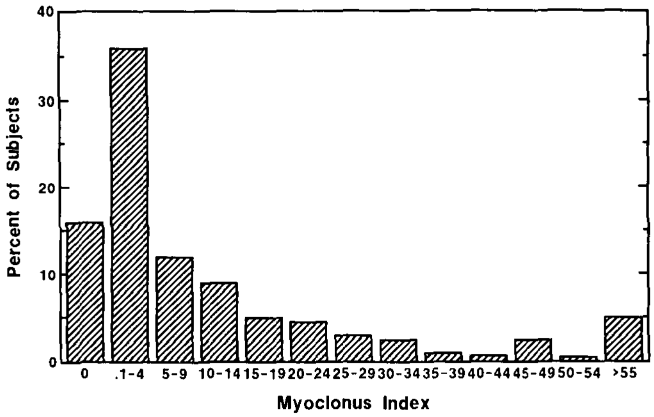

FIG. 1. Distribution of myoclonus index.

the night while you are asleep. If yes, how many times a night?" A postsleep questionnaire asked questions about quality of sleep during the recordings. Copies of the interview questionnaire can be obtained from the authors.

Sleep recording. A four-channel modified Medilog/Respitrace portable recording system was used (9,20). Tibialis electromyogram (EMG), summed from electrodes on the anterior of both lower legs, was recorded to identify leg jerks. Wrist activity (21) (to distinguish wake from sleep) and respiration were also recorded. The recording system has been validated (22). The correlation between polysomnograms and Medilog for determining myoclonus index (MI) was $r_s = 0.64$ ($p < 0.005$).

The average duration of recordings was 15 hr. Recordings were scored for total sleep time (TST), wake after sleep onset (WASO), number of awakenings, number of apneas and number of leg jerks. MI (the number of leg jerks per hour of sleep) was computed. In accordance with published criteria (23), tibialis EMG bursts were scored if they were 0.5–5.0 sec in duration with an interevent interval of 5–120 sec. Such "leg jerks" were only counted if they were part of a series of three or more consecutive movements. Leg jerks at the end of hypoventilations and apneas were included in the count.

Data analyses. Nonparametric tests (e.g. Kruskal–Wallis, chi-square, Spearman rank correlations) were computed. To develop a model for predicting PLMS, we used logistic regression analyses with backward elimination (24). The Hosmer–Lemeshow method was used to test the goodness-of-fit of the model. Those variables that were statistically significant in univariate analyses were used in the logistic regression analyses.

Women tended to be older than men (Kruskal–Wallis, p = 0.20), although the confounding was not statistically significant. However, there remained the potential for an age effect that would not be detectable if gender were not controlled in the analysis, i.e. if women tended to have a lower MI than men. Controlled analyses were performed using the extended Mantel–Haenszel procedure (25).

RESULTS

The sample. The mean age of the 232 women was 72.4 yr (SD = 6.4, range = 65–95). The mean age of the 195 men was 72.6 yr (SD = 5.7, range = 65–91). The combined mean age was 72.5 yr (SD = 6.1). The general health of the subjects is described in the accompanying article (18).

The 427 elderly recorded were compared on the telephone interview items with the 1,085 elderly people not recorded. Those recorded reported more history of leg kicks (16% vs. 10%; $p < 0.0001$) than those not recorded. As previously reported, there were fewer women (58%) agreeing to participate than men (72%) ($p < 0.001$) and those recorded tended to be younger ($p < 0.004$), better educated ($p < 0.001$), white ($p < 0.02$) and in higher income brackets ($p < 0.001$) (18).

PLMS Results

Prevalence of PLMS. Of the total sample of 427 elderly, leg jerk data were lost on 7 people. An arbitrary criterion of MI ≥ 5 (i.e. ≥5 leg jerks per hour of sleep) was used (26). Of the remaining 420 elderly, 45% (n = 189) had an MI ≥5. Ten percent of all subjects had both an MI ≥5 and an apnea index, AI, ≥5. There was little difference between the sexes in prevalence of MI, with 44% (n = 100) of the women and 46% (n = 89) of the men having MI ≥ 5. Mean indices are shown in Table 1. Men had a significantly higher MI than women (p = 0.02). The distribution of MI is shown in Fig. 1. The percentages of men and women with MI at different criterion levels and different ages are shown in Table 2.

TABLE 2. *Distribution of men and women, by decade, with an MI <5, ≥5, ≥10 and ≥20*

	MI < 5		MI ≥ 5		MI ≥ 10		MI ≥ 20	
	n	%[a]	n	%	n	%	n	%
Age								
65–69								
Men (n = 83)	45	54	38	46	28	34	17	20
Women (n = 83)	49	59	34	41	23	28	10	12
Total (n = 166)	94	57	72	43	51	31	27	16
70–79								
Men (n = 90)	50	56	40	44	32	36	25	28
Women (n = 110)	63	57	47	43	34	31	15	14
Total (n = 200)	113	57	87	44	66	33	40	20
80–99								
Men (n = 19)	8	42	11	58	7	37	5	26
Women (n = 35)	16	46	19	54	18	51	11	31
Total (n = 54)	24	44	30	56	25	46	16	30
65–99								
Men (n = 192)	103	54	89	46	67	35	47	25
Women (n = 228)	128	56	100	44	75	33	36	16
Total (n = 420)	231	55	189	45	142	34	83	20

[a] Percentages = within gender and within age group.

Association of age and gender with degree of PLMS. The trends evident in Table 2 were investigated by treating MI as a continuous variable and taking into account the confounding between age and gender. The women tended to be slightly older and have slightly lower MI than the men. As a whole, there was a small positive correlation between age and MI. The following trends became significant when confounding was taken into account. The association of age with MI controlled for gender was statistically significant (Mantel–Haenszel, p = 0.044) and, conversely, the association of gender with MI controlled for age was also statistically significant (Mantel–Haenszel, p = 0.016).

Items associated with PLMS. When univariate analyses were done (i.e. Kruskal–Wallis tests), subjects with PLMS reported being less satisfied with their sleep and tended to sleep alone. They gave histories of kicking at night, as well as histories of bronchitis, swollen tonsils and emphysema (Table 3).

Higher MI was associated with reported breathing problems (other than snoring, breath holding or shortness of breath) ($r_s = 0.19$, $p < 0.001$) and with a history of leg jerks ($r_s = 0.14$, $p < 0.009$).

In a study of this size, negative results are also interesting. There were no significant differences between those with and without PLMS in total sleep time reported, sleep onset latency or reported history of back and neck problems.

Stepwise logistic regression results. The following three factors were significantly associated with MI ≥ 5: nasal congestion, low household income and low amounts of inadvertent napping (Table 4). Although this model was useful in identifying factors associated with MI ≥ 5, it is not recommended for predictive purposes. With a 0.5 probability point as the cut-off, the model does a good job of identifying those with MI < 5 (specificity was 83%). On the other hand, only 36% of those with MI ≥ 5 were given greater than 0.5 probability for having the condition. This low sensitivity is further indicated by the lack of any subjects with predicted probability greater than 0.73 for having MI ≥ 5. The fact that the model fits the data does not imply that it is a useful model for prediction.

DISCUSSION

In a randomly selected sample of community-dwelling persons 65 yr and older, the prevalence rate of PLMS was 45%.

The true prevalence of PLMS in younger adults is not known, but it is thought to be lower than the prevalence in the elderly (3,6,9,27). In the elderly, the prevalence seems to be equally distributed among men and women across all ages between 65 and 89 yr. However, in the younger decades (65–79 yr), almost twice as many men had relatively severe PLMS (MI ≥ 20) than women (Table 2). It is important to note that the confounding of age and gender hid the importance of each factor, which was not the case for sleep apnea (18). The overall severity of PLMS seen in this group of elderly was moderate with 34% having an MI ≥ 10 and 20% having an MI ≥ 20. One elderly volunteer had 789 leg kicks for an MI of 271!

Clearly, our results are for the sample that was willing to be tested. Potential biases may exist and we can only speculate to what extent. Nonrespondents, i.e. those unwilling to have their sleep recorded, reported leg kicks on telephone interview less commonly, sug-

TABLE 3. *Mean MI for associated factors of myoclonus index*[a]

	n	Mean MI
Sleep satisfaction		
Very satisfied	179	11.0
Moderately satisfied	156	15.1
Somewhat troubled	52	15.0
Very troubled	28	20.5
		($p = 0.04$)[b]
Share a room		
Roommate	176	11.4
No roommate	242	15.2
		($p = 0.03$)
Share a bed		
Bedmate	131	11.7
No bedmate	287	14.4
		($p = 0.04$)
Leg kicks		
Never	227	12.1
Kick once or more per night	62	24.0
		($p = 0.002$)
Bronchitis		
Never had	265	11.9
Had	117	17.4
Has now	35	14.1
		($p = 0.01$)
Swollen tonsils		
Never had	123	9.2
Had	283	14.8
		($p = 0.03$)
Emphysema		
Never had	386	12.4
Has now	21	35.7
		($p = 0.02$)

[a] Based on responses from home interview; only those with $p \leq 0.05$ are shown.
[b] Kruskal–Wallis p value.

TABLE 4. *Logistic regression coefficients by factors (n = 420)*

Dependent variable	Factors	Coefficient (B)	p value	Hosmer–Lemeshow goodness-of-fit p value
MI	Constant	0.217	0.38	0.47[a]
	Frequency of nasal congestion	0.030	0.002	
	Household income	−0.121	0.023	
	Inadvertent napping	−0.558	0.002	

[a] Values close to zero indicate poor fit.

gesting our sample may have been biased toward symptomatic subjects. On the other hand, telephone reports of leg kicks were not correlated with objective MI. Correcting for age and sex biases, the estimated rate of MI $\geq$ 5 standardized for the United States population over age 65 yr was not different from the 45% with an MI $\geq$5 found among our 420 volunteers (i.e. 44.9%).

PLMS is exceptionally common in the elderly population; however, the variability of leg jerks from night to night is considerable. In two studies, we observed that the night-to-night reliability of MIs was only r_s = 0.43 and r_s = 0.28. It would not be surprising if much of the variance between symptoms and predicted MIs was due to night-to-night variability in this measure rather than to poor correspondence between symptoms and physiologic phenomena. This is supported by the results in which a morning interview item, specifically estimating the previous night's awakenings, proved to be by far the strongest correlate of the MI (multiple regression $r = 0.23$, $p < 0.001$). One might question whether some awakenings were related to sleep apnea in these patients; however, the correlation between AI and MI was extremely low ($r_s = 0.05$).

It has previously been reported that subjects with MI > 5 sleep less than those with fewer leg jerks (19,23). Although not significant ($p = 0.29$), this trend was observed in these analyses (370 min vs. 381 min). There was evidence for some sleep disturbance associated with leg jerks, considering the elevated MIs of those reporting less sleep satisfaction and the tendency of those with high indices to lack roommates or bedmates. Nevertheless, there was no evidence that disturbed sleep due to myoclonus caused increased daytime somnolence. Reports of inadvertent napping were associated with a low MI. This needs further study.

A surprising finding, though previously noted by us (12), was the association of high MIs with symptoms of impaired breathing such as reported bronchitis, swollen tonsils, emphysema and other breathing problems. Because leg jerks associated with apneas were scored, the possibility that periodic respiratory disturbances account for these associations was considered, but these symptoms were not associated with high apnea indices. In addition, as mentioned above, the correlation between AI and MI was only $r_s = 0.05$. Only 10% of the sample had both AI $\geq$ 5 and MI $\geq$ 5. Thus, other explanations must be sought.

In conclusion, this study showed that mild PLMS is extremely prevalent among elderly Americans. When we consider the high prevalence of AI $\geq$ 5 (18) and MI $\geq$ 5, we find that one or both are found among the majority (58%) of elderly. Although these mild disturbances were significantly associated with various symptoms, the associations were weak. It would be difficult to screen for PLMS based on symptoms alone. The fact that our symptom-based model was insensitive is not as serious a problem as it would have been in the case of a life-threatening curable disease. In the elderly, mild PLMS, like sleep apnea, is usually occult. More research is needed about the etiology and longitudinal changes associated with PLMS.

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