Periodic Limb Movements Are Associated with Vasomotor Symptoms

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Study Objectives: Periodic limb movements (PLMs) are characterized by involuntary movements of the lower extremity during sleep. The etiology of PLM has been suggested to involve the dopaminergic system which, in turn, can be modulated by estrogen. It is currently unknown whether PLMs are associated with the menopausal transition and/or concomitant vasomotor symptoms. The aim of the present study was to examine if objectively diagnosed PLMs (with and without arousals) are more common in postmenopausal women or in women with vasomotor symptoms. A secondary aim was to analyze the influence of PLMs on self-reported HRQoL.

Methods: A community-based sample of 348 women underwent full-night polysomnography. PLMs (index > 15) and associated arousals (PLM arousal index > 5) were evaluated according to AASM scoring rules. Health-related quality of life was measured using the SF-36 questionnaire. The occurrence of peri- and postmenopausal symptoms were evaluated by a

questionnaire and plasma levels of follicle stimulating hormone (FSH) were measured.

Results: After adjusting for confounding factors, vasomotor symptoms remained a significant explanatory factor for the occurrence of PLMs (adj. OR 1.86, 95% CI 1.03-3.37). In women with PLM arousals, adjusted OR for vasomotor symptoms was 1.61, 95% CI 0.76-3.42. PLMs did not seem to affect HRQoL.

Conclusion: We found that clinically significant PLMs, but not PLM with arousals, were more common among women with vasomotor symptoms, even after controlling for confounding factors. Menopausal status *per se*, as evidenced by FSH in the postmenopausal range, was not associated with PLMs.

Keywords: Periodic limb movements, women, menopause

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Periodic limb movements (PLMs) during sleep were first described in 1953 as “nocturnal myoclonus,” and were at that time thought to have similarities to nocturnal epilepsy.¹ The pathophysiological mechanisms of PLMs are unclear, but abnormal hyperexcitability (or diminished inhibition) in the lumbosacral and cervical segments of the spinal cord have been hypothesized to be possible causes.² PLMs are characterized by involuntary movements of the lower extremities, specifically the toes, ankle, knees, and hips, typically lasting between 0.5 and 10 seconds. The patient is usually unaware of the limb movements or the frequent sleep disruptions, and PLMs are often an incidental finding at polysomnography (PSG).³ PLMs may cause microarousals, leaving the affected patient fatigued the following day. Previously, it was assumed that PLMs were the cause of these arousals, but more recent studies have revealed that PLMs and arousals are associated in a more complex and non-unidirectional manner. Arousals can occur before, during, and after leg movements, indicating that the phenomenon is associated with an underlying arousal disorder.⁴

The exact prevalence of PLMs is unknown. They appear to be rare in children, to progress with advancing age, and to be more common in females than in males.^{5,6} In studies where PLMs have been objectively documented (PLM episodes/h of sleep > 5), the prevalence was 5% to 6% in younger adults, and 25% to 58% among elderly people.⁷ The

BRIEF SUMMARY

Current Knowledge/Study Rationale: Sleep disturbances affect a substantial fraction of women during the menopausal transition, and female sex hormones are possibly involved in the origin of PLMs. It is currently unknown whether PLMs are associated with the menopausal transition and/or concomitant vasomotor symptoms.

Study Impact: This study shows an association between symptoms related to declining levels of estrogen, i.e. vasomotor symptoms, and PLMs. Future studies should address the possibility of using hormone replacement therapy in postmenopausal women with PLMD.

diagnosis of periodic limb movement disorder (PLMD) is established when the affected individual also has insomnia and/or excessive daytime drowsiness. By subjective reports, the prevalence of PLMD has been estimated to be 3.9% in the general population.⁶

Restless legs syndrome (RLS) is a common sensory-motor disorder that produces uncomfortable sensations and a constant urge to move the lower limbs, and has a typical diurnal pattern with a peak of symptoms during rest periods in the evening and at night. RLS has also been reported to be associated with cardiovascular disease (CVD).⁸ In contrast to PLMs, the diagnosis of RLS is based on the patient's subjective symptoms. PLMs are related to RLS, and the majority of patients with RLS display PLMs during sleep.⁹ Prior studies have discussed the

possibility that hormones can play a role in the clinical manifestation of both PLMs and RLS in women.¹⁰ Among peri- and postmenopausal women who reported disturbed sleep, 36% fulfilled the criteria of PLMs and PLMs were one of the predictors of objective affected sleep quality.¹¹ Estrogen therapy has been reported to reduce PLMs,¹² and a later study observed that estrogen in addition to progesterone was more effective than estrogen alone in decreasing the prevalence of PLMs.¹³ RLS is approximately twice as common in women as men, and its prevalence increases following the onset of menopause.^{14,15} A previous report has suggested that RLS is associated with vasomotor symptoms.¹⁵

As sleep disturbances affect a substantial fraction of women during the menopausal transition,¹⁶ and as hormones such as estrogen and progesterone may influence both PLMs and RLS, the primary aim of the present study was to evaluate if PLMs are more common in postmenopausal women and/or in women with vasomotor symptoms, while adjusting for confounding factors. Another aim was to analyze the influence of PLMs on self-reported health related quality of life.

MATERIALS AND METHODS

Subjects

Ten thousand women (age ≥ 20 years) were randomly selected from the general population of the municipality of Uppsala, Sweden. Potential participants were sent postal questionnaires that included questions about demographics, sleep disturbances, and hormonal status, with a total response rate of 71.6%. In a second phase of the study, a sample of 400 women, aged 20 to 70 years that contained an oversampling of women who reported snoring¹⁷ were randomly selected from the responders of the first phase ($n = 6,515$). These women underwent a full night polysomnographic recording in their own homes (with the exception of 6 recordings, which were performed at the clinic). Women with severe somatic or psychiatric disease, who were likely not able to manage the ambulatory recording equipment, were excluded. Informed consent was obtained from all participants, and the study was approved by the Ethics Committee at the Medical Faculty at Uppsala University.

The ambulatory EMBLA system (Flaga Inc., Reykjavik, Iceland) was used for polysomnographic recordings. The recordings were performed between November 2001 and February 2004 and included bipolar continuous EEG recordings (C3-A2, C4-A1, left and right horizontal); electrocuculograms; airflow (nasal flow pressure sensor and oronasal thermistor); respiratory effort from piezoelectric belts around the abdomen and chest; finger oximetry; ECG; pharyngeal sounds by a piezo vibration sensor; and a body position sensor. Leg activity was recorded from both tibialis anterior muscles. An obstructive apnea was defined as cessation of airflow in both nasal pressure and oronasal thermistor ≥ 10 sec with continuing abdominal and thoracic movements. An obstructive hypopnea was defined as 50% reduction in both oronasal thermistor and nasal pressure ≥ 10 sec, compared with baseline, accompanied by abdominal and thoracic movements in combination with an arousal or an oxygen desaturation $\geq 3\%$. The obstructive apnea-hypopnea index (AHI) was defined as the mean number

of obstructive apneas and hypopneas per hour of sleep.¹⁸ Data were downloaded to analysis software (Somnologica; Flaga Inc.). For a useful recording, a sleep time ≥ 4 h was required, and no parameter was allowed to be lost > 20 minutes during the recording. On the morning following the polysomnography, the fasting women returned to the sleep laboratory. Height and weight were measured, and a research nurse took venous blood samples. Body mass index (BMI) was calculated in kilograms per meters squared.

To obtain the maximum quality and objective assessment of the polysomnographic measures, each recording was evaluated according to PLM scoring rules from the American Academy of Sleep Medicine (AASM; 2007 Manual)¹⁹ by an external registered polysomnographic technologist who was blinded to the hormonal status of the individuals. PLM associated with arousals from apneas, hypopneas, or respiratory effort related arousals (RERAs) were not scored. A rate > 15 PLM episodes per hour of sleep (PLM index) is considered clinically significant.²⁰

For the purposes of the present study, the diagnosis of PLM was made for women who had a PLM index > 15 ($n = 93$). In order to further examine the consequences of PLM arousals, women with PLM indexes > 15 and PLM arousal indexes > 5 were determined to be suffering from PLM arousals ($n = 49$). Two-hundred forty-three women with PLM indexes < 15 and PLM arousal indexes < 5 served as controls.

Questionnaires

The following questionnaires were filled out on the same evening as the polysomnographic recording:

RLS was diagnosed according to the International Restless Legs Syndrome Study Group standardized criteria (modified 2003).²¹ The essential criteria for this syndrome were: (1) having an urge to move the legs, usually accompanied or caused by uncomfortable and unpleasant sensations in the legs; (2) experiencing the urge to move or unpleasant sensations beginning or worsening during periods of rest or inactivity, such as lying down or sitting; (3) having the urge to move or experiencing unpleasant sensations that are partially or totally relieved by movement, such as walking or stretching, at least as long as the activity continues; (4) having the urge to move or experiencing unpleasant sensations that are worse in the evening or night than they are during the day, or which only occur in the evening or night. Each of these 4 criteria had to be met for the provisional study diagnosis of RLS in this study. Over time it has become clear that the positive predictive value of many RLS screening questionnaires may be low, and that many individuals who are identified as RLS sufferers by these screening questionnaires instead have other conditions that can mimic the features of RLS by satisfying the 4 diagnostic criteria.²² In the current study however, RLS status was only used for adjustments, and the low positive predictive value of this measure was thus not considered to be problematic.

The Short Form Health Survey (SF-36) was used to evaluate each patient's reported health. This instrument assesses an individual's health-related quality of life across a range of patient populations with different medical conditions. SF-36 scores range from 1 to 100 for each attribute. A high score indicates a

better physical component summary (PCS) and mental component summary (MCS),²³ indicating better overall reported health.

Alcohol dependency was defined as a subject's having 2 positive answers on the 4-item CAGE (Cut down, Annoyed by criticism, Guilty about drinking, Eye-opener drinks) questionnaire.²⁴

The subjects in the current report also completed a study-specific questionnaire that included questions on medical history, smoking, physical activity, medication, and hormonal status. In this questionnaire, subjects were asked if they had ever smoked regularly > 6 months and whether they were currently smokers or ex-smokers. The level of physical activity during leisure time was categorized into 4 groups, with a value of 1 for the lowest and 4 for the highest level of activity. The 4 values were dichotomized as low activity (levels 1 and 2) and high activity (levels 3 and 4). A low level of physical activity was defined as spending most of one's time in front of the television, reading, or engaging in other sedentary activities. The highest level included regular physical activity such as swimming, jogging, tennis, aerobic exercise ≥ 3 h/week, or even more vigorous activities on a weekly basis. The categorization was adopted from a large population-based, prospective study on physical activity and mortality in women.²⁵

Subjects were classified as having hypertension if they reported attending regular medical examinations for hypertension and/or answered "yes" to the question: "Do you have high blood pressure?" Similarly, those who answered "yes" to the question "Do you have diabetes?" and/or said that they attended regular medical examinations for diabetes were classified as having diabetes. Histories of previous myocardial infarction, heart failure, and stroke were also obtained by yes/no questions. Any type of regular medication was also documented.

Hormonal status was evaluated by the following questions: are you suffering from vasomotor symptoms (hot flushes and sweating)? How many menstruations have you experienced within the last 6 months or the last year? When did you experience your last menstruation? Are you currently being treated with any female steroid hormones? Have you been treated with female steroid hormones in the past? If so, when did you terminate treatment? For the purpose of the present study, only women who answered these questions were included.

FSH and Hemoglobin Assays

A blood sample was taken from each subject in order to measure circulating levels of follicle stimulating hormone (FSH) and hemoglobin (Hb) using routine methods at the Department of Clinical Chemistry, Uppsala University Hospital. However, during the study period, the laboratory methods for FSH determination were altered; therefore, the FSH levels in this study were used merely to confirm menopausal status, using the reference intervals determined for each laboratory method. Because many women used HRT or intrauterine hormonal devices, it was assumed that FSH levels in the postmenopausal range would be a better indicator of postmenopausal status than amenorrhea.

Statistics

Unpaired t-tests for numerical data and χ^2 tests for categorical data were used to analyze differences in characteristics,

clinical and endocrine variables between subjects with PLMs index > 15, PLM arousals, and controls, respectively. Multiple logistic regression analyses were performed to estimate the risk, as approximated by the adjusted odds ratio (OR), of suffering from PLMs associated with vasomotor symptoms. The ORs, with 95% confidence intervals (CI), were calculated by means of multiple logistic regressions in order to determine the influence of potential confounding factors. The inclusion of confounding variables was based on significant findings in the bivariate analyses, with the exception of smoking and apnea-hypopnea index (AHI), which were forced into the model. The latter variable was included because of the oversampling of women with obstructive sleep disorder, which was categorized as having an AHI > 15. Measures of self-rated physical health, according to the SF-36-PCS, were categorized in quartiles, with subjects having scores in the highest quartile were denoted as controls. A p-value < 0.05 was considered to be statistically significant. Statistical analyses were performed using IBM SPSS Statistics 20 (SPSS, Chicago, IL).

RESULTS

Four hundred women were recruited for the study. Complete PSG recordings were obtained from all subjects. Due to technical difficulties, PLMs could not be scored in 7 women. In addition, 49 women did not complete the questionnaire concerning hormonal status and were excluded. Hence, 344 women were available for analysis. Of these, 243 women had a PLM index ≤ 15 and a PLM arousal index < 5 and were denoted as controls. Ninety-three women had a PLM index > 15 (women with PLM); of these, 49 also had a PLM arousal index > 5 (women with PLM arousals). Women with PLMs and PLM arousals were approximately 5 years older than controls. Women with PLMs were less likely than controls to be employed. There were no statistically significant differences in BMI, smoking habits, alcohol dependence, or degree of physical activity between the PLM groups and controls (**Table 1**).

As expected, women with PLMs and PLM arousals reported RLS more often than controls, and obstructive sleep apnea syndrome (evidenced by AHI > 15) tended to be more common in women with PLMs (**Table 2**). Women with PLM arousals reported hypertension more often (**Table 2**). Although chronic diseases and history of cardiovascular disease were rare in the study population, women with PLMs and PLM arousals had lower self-reported physical health (SF-36-PCS) than controls, respectively.

Wake time after sleep onset in women with PLMs was 71 ± 52 min, in women with PLM arousals 75 ± 52 min and in controls 64 ± 49 min in controls, $p = 0.3$ and $p = 0.2$ respectively. WASO in women with vasomotor symptoms was 73 ± 50 min and among those without vasomotor symptoms 63 ± 49 min, $p = 0.1$.

In our univariate analyses, FSH levels in the postmenopausal range and ongoing vasomotor symptoms were both associated with PLMs. Women with PLMs also reported the current use of hormonal replacement therapy more often than did controls, although this difference was not significant ($p = 0.059$; **Table 3**). A similar pattern was noted in women with PLM

Table 1—Population characteristics

	Controls (n = 243)	Women with PLMs (n = 93)	p-value	Women with PLM arousals (n = 49)	p-value
Age, years	48.1 ± 12.0	53.4 ± 9.7	0.001	52.7 ± 9.9	0.009
BMI, kg/m ²	26.3 ± 5.1	27.0 ± 4.5	0.3	27.6 ± 4.2	0.1
Smokers, n (%)	56 (22.0)	19 (20.4)	0.9	12 (24.5)	0.8
Alcohol dependence, n (%)	14 (5.6)	3 (3.3)	0.6	3 (6.4)	0.7
Low physical activity, n (%)	199 (81.9)	81 (87.1)	0.2	45 (91.8)	0.1
High physical activity, n (%)	43 (17.7)	11 (11.8)	0.3	4 (8.2)	0.2
Employed/studying, n (%)	214 (90.7)	69 (80.2)	0.024	38 (84.4)	0.2

Data presented as mean ± SD or n (%). Women diagnosed with PLMs had a PLM index > 15, whereas women with PLM arousals included those who had a PLM index > 15 and PLM arousal index > 5.

Table 2—Clinical variables in women with PLMs, women with PLM arousals, and controls

	Controls (n = 243)	Women with PLMs (n = 93)	p-value	Women with PLM arousals (n = 49)	p-value
Apnea-hypopnea index >15, n (%)	72 (28.8)	37 (39.8)	0.1	18 (36.7)	0.3
Regular check-ups due to hypertension, n (%)	32 (12.7)	19 (20.4)	0.1	14 (28.6)	0.007
Myocardial infarction, n (%)	0 (0)	3 (3.3)	0.019	0 (0)	—
Heart failure, n (%)	1 (0.4)	2 (2.2)	0.2	1 (2.1)	0.3
Stroke, n (%)	0 (0.0)	1 (1.1)	0.3	0 (0)	—
Diabetes, n (%)	4 (1.6)	5 (5.4)	0.1	2 (4.2)	0.2
Anemia (hemoglobin < 11.5 g/L), n (%)	6 (2.4)	5 (5.4)	0.2	2 (4.2)	0.6
Antidepressant drugs	19 (9.2)	12 (16.9)	0.1	11 (27.5)	0.001
RLS, n (%)	62 (25.1)	54 (60.0)	0.001	32 (66.7)	0.001
SF-36-PCS	50.0 ± 10.1	45.4 ± 10.8	0.001	45.2 ± 10.5	0.005
SF-36-MCS	46.2 ± 11.1	45.9 ± 10.9	0.7	44.4 ± 11.8	0.3

Data are presented as n (%) or mean ± SD. Women with PLMs had a PLM index > 15, whereas women with PLM arousals included those who had a PLM index > 15 and a PLM arousal index > 5. Missing values were prevalent in 1.0–2.8% of cases. RLS, restless legs syndrome; SF-36-PCS, Short Form Health Survey physical component score; SF-36-MCS, Short Form Health Survey mental component score.

Table 3—Endocrine variables in women with PLMs, women with PLM arousals, and controls

	Controls (n = 243)	Women with PLMs (n = 93)	p-value	Women with PLM arousals (n = 49)	p-value
FSH in postmenopausal range, n (%)	104 (42.8)	55 (59.1)	0.007	27 (55.1)	0.1
Current HRT use, n (%)	32 (13.2)	20 (21.5)	0.1	11 (22.4)	0.1
Vasomotor symptoms, n (%)	62 (25.5)	36 (38.7)	0.017	18 (36.7)	0.1

Data presented as n (%). Women with PLMs had a PLM index > 15, whereas women with PLM arousals included those who had a PLM index > 15 and a PLM arousal index > 5. FSH, follicular stimulating hormone; HRT, hormone replacement therapy.

arousals, but none of the endocrine variables reached statistical significance (**Table 3**).

After adjusting for postmenopausal status (FSH in postmenopausal range), age, smoking, prevalence of RLS, prevalence of obstructive sleep apnea syndrome (AHI > 15), and self-rated physical health, vasomotor symptoms remained a significant explanatory factor for the occurrence of PLMs (adj. OR 1.86, 95% CI 1.03–3.37). Following adjustment for age, FSH in postmenopausal range did not remain a significant explanatory variable for the presence of PLMs. As expected, RLS was also significantly associated with PLMs (adj. OR 4.37, 95% CI 2.53–7.55; **Table 4**). A similar regression model was performed in women with PLM arousals, resulting in an adjusted OR for vasomotor symptoms of 1.61, 95% CI 0.76–3.42.

DISCUSSION

The main finding of the present study was that women with PLMs more often suffered from peri- and postmenopausal vasomotor symptoms, whereas postmenopausal status *per se*, following adjustment for age, did not remain a significant explanatory variable. These findings are in accordance with the results from a previous study in women with RLS, in which vasomotor symptoms during the menopausal transition, but not postmenopausal status, were associated with increased occurrence of RLS.¹⁵

The mechanisms by which the consequences of decreased ovarian function (vasomotor symptoms) are associated with PLMs, but not with menopause *per se* (increased FSH levels),

is not clear. The most straightforward explanation could be that women with PLMs have disturbed sleep and/or arousals, and thus might spend more time awake are more inclined to note vasomotor symptoms such as night sweats. In fact, we found a clear trend towards longer time awake after sleep onset in women with PLMs, PLM arousals and in women with vasomotor symptoms, but none of the results were significant. However, inferences about causal relationships between these sleep disturbing factors are not possible in this cross-sectional study design.

Vasomotor symptoms are considered to be indicative of estrogen deficiency, although no clear-cut relationship between serum concentrations of estrogen (or FSH) have been reported.²⁶ It is thus possible that the loss of estrogen, which has multiple effects on neuronal function and neurotransmitter systems, might influence the propensity to develop PLMs. Estrogen receptors are expressed in brain areas responsible for sleep regulation. Estrogen signaling also increases the synthesis of acetylcholine, delays the turnover of serotonin, regulates serotonin transport and binding in the brain, and has both agonistic and antagonistic effects on the dopaminergic system. Long-term exposure to estrogen both increases dopamine uptake and decreases dopamine concentrations in dopaminergic areas in the brain. Of relevance to the study of PLM, it has been hypothesized that decreased estrogen levels worsen sleep movement disorders via decreasing the abundance of dopamine receptors or impacting catechol-O-methyltransferase (COMT) activity, the enzyme that degrades dopamine.²⁷ However, it may be informative to point out that there is no evidence on a direct link between dopamine levels and hot flashes.

Emerging evidence also suggests that symptoms associated with sleep-related movement disorders may be associated with a low oxygenation of peripheral tissues. Remodeling of capillary geometry and a lower maximal oxygen uptake has been found in the tibialis anterior muscle of RLS patients.²⁸ Estrogen has been shown to improve vascularization²⁹ and to also, via increased nitric oxide production and vasodilatation,³⁰ ultimately increase the oxygen supply. Nitric oxide has recently been reported to influence dopaminergic processes, promoting speculation on that the actions of this molecule may provide a link between the peripheral and central hypotheses of the origin of RLS/PLM.³¹ In addition, higher metabolism in the periphery during night sweats could lead to a build-up of lactic acid in the muscles, which leads to an increased excitability of nerve-muscle plates and to more frequent PLMs.³²

Although PLMs were significantly associated with vasomotor symptoms in the present study, no such association was found in women with PLM arousals. It is likely that the current study simply did not contain enough women with PLM arousals to reveal significant associations with menopause and/or vasomotor symptoms (indicating a type II error). With a larger sample of women with PLM arousals, it is possible that a positive association with vasomotor symptoms might have been revealed, but this remains to be established. On the other hand, arousals are common in women with PLMs, and spectral EEG may provide objective sleep measures indicating higher arousal levels in women with vasomotor symptoms.³³ Our findings of an association between vasomotor symptoms and PLMs adds further complexity to the picture, and points to the fact that

Table 4—Adjusted odds ratios and 95% confidence intervals for the explanatory variables of PLMs index > 15

	Adjusted odds ratio	95% confidence interval
Vasomotor symptoms	1.86	1.03-3.37
FSH in postmenopausal range	1.22	0.57-2.61
Age	1.03	0.99-1.07
Smoking	1.44	0.74-2.81
RLS	4.37	2.53-7.55
Apnea-hypopnea index > 15	1.00	0.55-1.81
Self-rated physical health		
Highest quartile	1.00	
Intermediate quartiles	1.38	0.67-2.82
Lowest quartile	2.03	0.89-4.61

Odds ratios are adjusted for all variables in the table. FSH, follicular stimulating hormone; RLS, restless legs syndrome.

the mechanisms involved in arousals, whether associated with PLMs or vasomotor symptoms, remain insufficiently clarified.

In the current study, PSG recording were available for only a single night, which is an important limitation for the interpretation of our findings. Because of observed night to night variability of PLMs, particularly in RLS patients,³⁴ it has been suggested that two consecutive full nights of PLM recordings may be necessary to make a valid estimate of the PLM index. However, this conclusion comes mostly from studies involving patients with sleep disorders such as RLS and PLMD.³⁵

Another limitation is that the cohort of women in this study was originally sampled for the evaluation of sleep disordered breathing. Therefore, the data in this study may not be used to estimate population-based prevalence rates of PLMs (or RLS) in women. However, for the associative analyses between vasomotor symptoms, menopause, and PLMs, the study design was considered reasonable. Furthermore, the prevalence of obstructive sleep apnea was adjusted for in the final regression analysis. The complex mechanisms underlying the association between OSA, RLS, and PLMs remain unclear. However, PLMs do not have an additive effect on the hypersomnia experienced by some sleep disordered breathing patients.³⁶

Even though RLS has been found to be associated with cardiovascular disease less is known about PLM and CVD. Due to the overall healthy population, this study did not add any information on the association between PLM and CVD.

We conclude that vasomotor symptoms are independently associated with PLMs and that ovarian steroids may play a role in the clinical manifestations of PLMs. At present, we may only speculate upon the biological mechanisms underlying this association; future studies should address the possibility of using hormone replacement therapy in postmenopausal women with PLMD.

ABBREVIATIONS

AASM, American Academy of Sleep Medicine
AHI, apnea-hypopnea index
BMI, body mass index

CVD, cardiovascular disease
 EEG, electroencephalogram
 EMG, electromyogram
 FSH, follicle stimulating hormone
 Hb, hemoglobin
 HRQoL, health-related quality of life
 HRT, hormone replacement therapy
 ICSD-2, International Classification of Sleep Disorders, 2nd ed
 LM, leg movement
 MCS, mental component summary
 OSA, obstructive sleep apnea
 PLMD, periodic limb movement disorder
 PLMs, periodic limb movements
 PCS, physical component summary
 PSG, polysomnography
 RLS, restless legs syndrome
 SF-36, Short Form Health Survey

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