Sleep Medicine: X 5 (2023) 100060

Contents lists available at ScienceDirect

Sleep Medicine: X

journal homepage: www.elsevier.com/locate/sleep

Factors associated with poor sleep quality in midlife Singaporean women: The Integrated Women's Health program (IWHP)

Beverly W.X. Wong [a], Yiong Huak Chan [b], Michael S. Kramer [a, c], Inger Sundström-Poromaa [d], Susan Logan [a], Jane A. Cauley [e], Eu-Leong Yong [a, *]

[a] Department of Obstetrics and Gynecology, National University Hospital, National University of Singapore, 119228, Singapore
[b] Yong Loo Lin School of Medicine, Biostatistics Unit, National University of Singapore, 117597, Singapore
[c] Departments of Epidemiology and Biostatistics and of Pediatrics, McGill University Faculty of Medicine, Montreal, Quebec, Canada
[d] Department of Women's and Children's Health, Uppsala University, Uppsala, Sweden
[e] Department of Epidemiology, University of Pittsburgh, School of Public Health, Pittsburgh, PA, 15261, United States

ARTICLE INFO

Article history:
Received 24 August 2022
Received in revised form
18 October 2022
Accepted 3 December 2022
Available online 9 December 2022

Keywords:
Sleep quality
Pittsburgh sleep quality index (PSQI)
Midlife women
Asian
Integrated Women's Health program (IWHP)

ABSTRACT

Objective: To examine factors associated with poor sleep quality in community-dwelling midlife women.
Methods: Healthy women (aged 45–69 years) of Chinese, Malay and Indian ethnicities attending well-women clinics at the National University Hospital, Singapore, completed the Pittsburgh Sleep Quality Index (PSQI). A PQSI score >5 denoted poor sleep quality. The women filled out validated questionnaires covering menopausal and genito-urinary symptoms, and mental health. Physical performance was measured. Bone mineral density and visceral adiposity were assessed by dual energy X-ray absorptiometry. Binary logistic regression analyses assessed independent factors for poor sleep.
Results: Poor sleep quality was reported in 38.2% of women (n = 1094, mean age: 56.4 ± 6.2 years). Indian women had higher sleep disturbance scores than Chinese women (mean ± SD: 1.33 ± 0.58 vs 1.17 ± 0.49). Malays experienced more daytime dysfunction (0.54 ± 0.60 vs 0.33 ± 0.55) and had a higher overall PSQI score (6.00 ± 3.31 vs 5.02 ± 2.97) than the Chinese. A low education level (aOR: 1.76, 95% CI: 1.01–3.05), feelings of irritability (2.67, 1.56–4.60) and vaginal dryness (1.62, 1.03–2.54) were associated with poor sleep quality in the adjusted multivariable model. Women with moderate to severe disability were ~3 times (2.99, 1.20–7.44) more likely to experience less than ideal sleep quality, while urinary incontinence (1.53, 1.08–2.17) and breast cancer history (2.77, 1.36–5.64) were also associates of poor sleep quality.
Conclusion: Self-reports of education level, irritability, vaginal dryness, disability, urinary incontinence, and breast cancer history were independently related to poor sleep. Ethnic differences suggest the need for targeted interventions among the ethnic groups.

1. Introduction

Sleep is important for optimal brain function and overall health [1]. Sleep deprivation leads to emotional distress, somatic problems, and reduced quality of life [2]. Long-term insomnia is associated with increased risk of cardiovascular disease [3]. Poor sleep quality and insomnia are more prevalent among women than men [4–6]. In Singapore, women (aged >18 years) are 1.44 times more likely to have poor sleep quality than men, based on the Pittsburgh Sleep Quality Index (PSQI) [4].

Previous studies suggest that postmenopausal women experience higher rates of sleep difficulties than premenopausal women [7]. The menopause transition in midlife women has been linked to vasomotor and psychological symptoms [7–10]. Vasomotor symptoms include hot flushes and night sweats, and have been associated with sleep difficulties, disturbances, and insomnia in large-scale cohort studies among midlife women [7,8,10–14]. These

Abbreviations: aOR, Adjusted odds ratio; CI, Confidence Interval; DXA, Dual-energy X-ray absorptiometry; IWHP, Integrated Women's Health Program; PSQI, Pittsburgh Sleep Quality Index; SPPB, Short Physical Performance Battery; SWAN, Study of Women's Health Across the Nation; VAT, Visceral adipose tissue.

* Corresponding author. Department of Obstetrics & Gynecology, Yong Loo Lin School of Medicine, National University of Singapore, National University Health System Tower Block, 1E Kent Ridge Road, 119288, Singapore.
E-mail address: obgyel@nus.edu.sg (E.-L. Yong).

https://doi.org/10.1016/j.sleepx.2022.100060

include the U.S.-based Study of Women's Health Across the Nation (SWAN) [10], and a large study of midlife women from 11 Latin American countries [8]. Anxiety and depression have also been linked to poor sleep quality [7,8,11–13,15–17]. Self-reported depression was associated with poor sleep outcomes (insomnia, sleep disturbances, restless sleep) among participants from the Seattle Midlife Women's Health Study [11]. Most sleep studies among midlife women to date have been conducted in Caucasian populations [7,8,10–13,17], while studies in Asian women have been small and non-representative [14,15], not specific to midlife [4,18], or were conducted in ethnically homogeneous Asian populations [16,19].

Ethnic differences in sleep quality have been observed, with Caucasians reporting better sleep quality than Blacks, Chinese, and Japanese in the US population [20]. Although the Singapore Mental Health Study reported Malays and Indians to have poorer sleep quality than Chinese [4], women-specific concerns like menopausal status, genito-urinary symptoms and other important health conditions were not examined then.

To identify women-specific factors that may affect poor sleep quality, we studied a wide range of socio-economic, demographic, lifestyle, menopausal symptomatology, and important health conditions in a cohort of community-dwelling women. Knowledge of these factors would inform gynaecologists, family practitioners and public health policy makers on appropriate measures to guide and educate midlife women on improving their sleep quality.

2. Methods

2.1. Study design and population

This is a cross-sectional study involving healthy women from the Integrated Women's Health Program (IWHP). Midlife women of Chinese, Malay and Indian ethnicities receiving routine gynaecological care from well-women clinics at the National University Hospital, Singapore, were recruited from September 2014 to October 2016 [21]. 2715 women were screened, 2191 women met the eligibility criteria, and 1201 women were enrolled (54.8% response rate). Eligibility criteria included being within the age range of 45–69 years and willingness to provide a blood sample. Exclusion criteria included pregnancy and physical or mental impairment [21]. This study was approved by the Domain Specific Review Board of the National Healthcare Group, Singapore (Reference number: 2014/00356). All participants provided written informed consent.

2.2. Assessment of sleep quality

The PSQI was used to assess subjective sleep quality and disturbances over the previous month [22]. 19 items in the PSQI are grouped into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication and daytime dysfunction. Each component is scored from 0 to 3 (no difficulty to severe difficulty), with a maximum of 21 points in total. A PSQI score >5 indicated poor sleep quality. This cut-off has a 89.6% sensitivity and 86.5% specificity in distinguishing between good and poor sleepers, as assessed using a comprehensive range of tools to evaluate sleep quality, including clinical and structured interviews, sleep questionnaires, diaries; direct physical observations of sleep, as well as polysomnographic findings [22].

2.3. Data collection

Participants self-reported their age, ethnicity, highest education level attained, current marital status, smoking, and alcohol consumption [21]. Low physical activity was defined as spending <150 min per week on moderate intensity physical activity and/or <75 min per week on vigorous intensity physical activity, measured by the Global Physical Activity Questionnaire [23]. Blood was drawn following an overnight fast and processed within 6 h. Liquid chromatography-tandem mass spectrometry was used to measure total serum 25-hydroxyvitamin D [24], with cut-off for deficiency set at ≤20 ng/ml [25].

Menopausal status (pre-, peri- or post-) was defined previously in our cohort [21]. The Menopause Rating Scale assessed the severity of menopausal symptoms [26] and comprised 11 symptoms divided into three domains: somatic (hot flushes, heart discomfort, joint or muscle discomfort, sleep problems); psychological (depressive mood, irritability, anxiety, physical mental exhaustion); and genito-urinary (sexual problems, bladder problems, vaginal dryness). Participants assigned a score from 0 (symptom is absent) to 4 (symptom is very severe) for each item, which was then individually dichotomized into (a) none or mild symptoms (0 or 1 point) and (b) moderate or severe symptoms (2–4 points).

Participants were asked to declare any existing or past health conditions [22]. These included diabetes, hypertension, rheumatoid arthritis, osteoarthritis, heart conditions (angina, heart attack, congestive heart failure, coronary bypass/angioplasty), asthma, and breast cancer history. Participants brought all prescribed and/or over-counter medications, supplements and traditional medications consumed in the past two weeks; a trained study coordinator recorded the dosage and consumption frequency. In addition to self-reported declaration of health conditions, participants were classified as diabetic if their fasting blood glucose level ≥7.0 mmol/l or they were taking anti-diabetic medications, as hypertensive if their systolic blood pressure 140 mmHg and/or diastolic blood pressure was ≥90 mmHg or they were taking anti-hypertensive drugs. Depression and/or anxiety symptoms were defined based on scores of ≥16 and/or ≥10 [27] using the validated Centre for Epidemiological Studies Depression Scale [28] and the General Anxiety Disorder Scale [29], respectively, or if anti-depressive medications were taken. Urinary incontinence was defined as having stress, urge or mixed incontinence or leakage, which were self-reported using the Pelvic Floor Disability Index [30]. The presence of osteoporosis at the femoral neck and/or lumbar spine was determined using dual-energy X-ray absorptiometry (DXA). Calculation of T-scores was based on reference data from Singaporean women at both sites, with a T-score of ≤ −2.5 indicating osteoporosis. Disability was measured using the WHO Disability Assessment Schedule 2.0 [31], which assessed six different functioning domains from a scale of 0–100 (complete disability). Scores ≥25 were classified as moderate to severe disability [32]. Women with three or more of any of these health conditions (diabetes, hypertension, depression and/or anxiety, urinary incontinence, osteoporosis, rheumatoid arthritis, osteoarthritis, heart conditions, asthma, moderate to severe disability, breast cancer history) were grouped into one category.

Height was measured twice (and the two measurements averaged), and weight measured once, by trained research assistants using an electronic measuring station (SECA 769). Participants dressed in light clothing and had their shoes removed and pockets emptied for these measurements. Body mass index was computed as body weight divided by height squared (kg/m^2) [21]. The cut-offs for Asian populations were as follows: underweight (<18.5 kg/m^2), normal (18.5–22.9 kg/m^2), overweight (23.0–27.4 kg/m^2) and obese (≥27.5 kg/m^2) [33]. Visceral adipose tissue (VAT) was measured using DXA and presented in tertiles of lowest (<88.6 cm^2), middle (88.6–131.0 cm^2) and highest (>131.0 cm^2).

Handgrip strength was tested by trained personal using a hand-held dynamometer (Jamar, Bolingbrook, IL). Four readings were taken, two on each arm, and the maximum value was analysed. Handgrip strength was presented dichotomously (<18 kg and ≥18 kg). The Short Physical Performance Battery (SPPB), a series of tests to assess lower extremity strength and physical performance, included a five-time repeated chair stand test, balance tests (semi-tandem stand, tandem stand, and one-leg stand) and balance walks [34]. The SPPB has a maximum of 12 points, with ≥10 points indicating high performance.

2.4. Statistical analysis

We examined associations between demographic, lifestyle, menopausal symptoms, health conditions and objectively measured physical characteristics and sleep quality. Crude associations with poor sleep quality were tested using Pearson's chi-square test. Several components of the Menopause Rating Scale, such as sleep problems, depressive mood, anxiety, and bladder problems were not examined, owing to their similarities with some of the health conditions assessed, including depression, anxiety, and urinary incontinence. One-way analysis of variance (ANOVA), with Bonferroni correction, examined crude differences between ethnicity and individual PSQI sleep components. Adjusted associations with poor sleep quality were assessed using binary logistic regression. Results are expressed as adjusted odds ratios (aOR) and 95% confidence intervals (CI). All results were analysed using IBM SPSS Statistics for Windows (version 28.0).

3. Results

3.1. Participant characteristics

Out of 1201 total women, we excluded 12 with missing sleep quality data and 95 who were on sleep medication, leaving an analytic sample of 1094 women. Among the latter women, 38.2% reported poor sleep quality (PSQI >5) (Table 1a and b). The mean age was 56.4 ± 6.2 years, 82.0% were Chinese, 19.4% had university degrees, and 81.0% were married. A very low proportion of women smoked (1.9%) or consumed alcohol (2.9%). Slightly more than one-third (39.5%) had low physical activity, and one-fifth (19.5%) were vitamin D-deficient.

Women with moderate to severe menopausal symptoms such as hot flushes, heart discomfort, joint or muscle discomfort, irritability, physical mental exhaustion, sexual problems, and vaginal dryness, were more likely to experience poor sleep quality compared to women with none to mild symptoms (Table 1a). Women with urinary incontinence, asthma, moderate to severe disability (compared to none to mild symptoms), a history of breast cancer, and with ≥3 health conditions were more likely to have poor sleep quality (Table 1b). Low to moderate SPPB performance was more likely to be crudely associated with poor sleep quality compared to high SPPB performance.

Age, ethnicity, highest education level, marital status, smoking status, alcohol consumption, physical activity, vitamin D status and menopausal status were not significantly associated with poor sleep quality. Nor were other health conditions and characteristics, such as diabetes, hypertension, depression and/or anxiety, osteoporosis, rheumatoid arthritis, osteoarthritis, heart conditions, body mass index, visceral adipose tissue, and handgrip strength.

3.2. PSQI components and global score by ethnicity

To better understand ethnic differences in poor sleep quality, we compared components of sleep quality amongst Chinese, Malay, and Indian women (Table 2). Indian women had a higher sleep disturbance score (mean ± SD: 1.33 ± 0.58 vs 1.17 ± 0.49) than Chinese women, while Malay women did not significantly differ from the other two ethnic groups. Malays reported a higher daytime dysfunction score (0.54 ± 0.60 vs 0.33 ± 0.55) and a higher overall PSQI global score (6.00 ± 3.31 vs 5.02 ± 2.97) than Chinese women, while Indian women did not differ significantly from the other two groups for both measures. No significant ethnic differences were observed in subjective sleep quality, sleep latency, sleep duration and habitual sleep efficiency.

3.3. Adjusted associations with poor sleep quality

Among our analytic sample of 1094 women, having a low education level (defined as no formal education or until the primary level) was associated with poor sleep quality (aOR: 1.76, 95% CI: 1.01−3.05) compared to having a university degree in the adjusted multivariable model (Table 3). Menopausal symptoms such as irritability and vaginal dryness were associated with a 2.67-fold (95% CI: 1.56−4.60) and a 1.62-fold (95% CI: 1.03−2.54) higher odds of poor sleep quality respectively. Women with moderate to severe disability were ~3 times (2.99, 1.20−7.44) more likely to experience less than ideal sleep quality, while urinary incontinence (1.53, 1.08−2.17) and breast cancer history (2.77, 1.36−5.64) were associates of poor sleep quality.

4. Discussion

We found that 38.2% of midlife Singaporean women self-reported poor sleep quality. A low education level, irritability, vaginal dryness, urinary incontinence, moderate to severe disability and breast cancer history were significantly related to poor sleep quality after multivariable adjustment. Indian women and Malay women had higher sleep disturbance scores, and higher daytime dysfunction scores and overall global PSQI scores respectively, than Chinese women.

The prevalence of poor sleep quality (38.2%) in our study concurs with findings from the SWAN study in U.S. (38.0%, n = 12,603 women, aged 40−55 years) [7]. However, our prevalence of 38.2% was higher than a Hong Kong study (26.0%, n = 305 women, mean age: 50.1 years) [15] as well as a Korean study (26.0%, n = 3000 women, n = 45−64 years) [16]. In Singapore, poor sleep quality was previously reported at a lower prevalence of 27.0% [4], possibly due a younger age range and inclusion of both men and women in that study. Our study is specific to midlife women and reasons for an increased prevalence of poor sleep quality include menopausal symptoms of irritability and vaginal dryness, urinary incontinence, breast cancer history and disability, as reported in our study, as well as vasomotor symptoms and depressive mood, as reported in other studies [7,14,35].

Our findings add to previous studies reporting associations of urinary incontinence [36,37] breast cancer history [38−40] and disability [41,42] with poor sleep quality. In our study, women with urinary incontinence were ~1.5 times more likely to have poor sleep quality. A study by Winkleman et al. reported that a higher frequency of incontinence correlates with a greater magnitude of sleep disturbance [37]. Frequent night time awakenings due to incontinence might lead to psychological stress and anxiety, as well as potential nocturnal sleep disorders [36]. Interventions among women with incontinence need to focus on sleep quality as an important outcome.

In our study, women with a history of breast cancer had a high risk of poor sleep quality (adjusted odds ratio: ~2.8) Similarly, a meta-analysis of 12 studies reported that sleep quality of women with breast cancer was found to deteriorate between 4 months and 1

Table 1a
Demographic and lifestyle factors and menopausal symptoms by sleep quality.

Characteristics	Total (n = 1094)	Poor sleep quality (PSQI >5) (n = 418, 38.2%)	P-value
Demographic and lifestyle factors			
Age, years			0.538
45-54	475	173 (36.4)	
55-64	481	192 (39.9)	
≥65	138	53 (38.4)	
Ethnicity			0.058
Chinese	897	328 (36.6)	
Malay	59	29 (49.2)	
Indian	106	47 (44.3)	
Highest education level			0.287
No formal or primary	160	70 (43.8)	
Pre-university	710	265 (37.3)	
University	212	78 (36.8)	
Marital status			0.613
Married	886	341 (38.5)	
Non-married	205	75 (36.6)	
Smoking			0.663
Yes	21	9 (42.9)	
No	1071	409 (38.2)	
Alcohol consumption			0.661
Yes	32	11 (34.4)	
No	1055	403 (38.2)	
Physical activity			0.913
Low	432	166 (38.4)	
High	651	248 (38.1)	
Vitamin D status			0.224
Deficient, ≤20 ng/ml	213	89 (41.8)	
Non-deficient, >20 ng/ml	872	325 (37.3)	
Menopausal symptoms			
Menopausal status			0.246
Premenopausal	138	44 (31.9)	
Perimenopausal	171	69 (40.4)	
Postmenopausal	785	305 (38.9)	
Somatic			
Hot flushes			<0.001
None to mild	838	293 (35.0)	
Moderate to severe	184	101 (54.9)	
Heart discomfort			<0.001
None to mild	962	358 (37.2)	
Moderate to severe	61	36 (59.0)	
Joint or muscle discomfort			<0.001
None to mild	699	235 (33.6)	
Moderate to severe	324	159 (49.1)	
Psychological			
Irritability			<0.001
None to mild	898	311 (34.6)	
Moderate to severe	124	83 (66.9)	
Physical mental exhaustion			<0.001
None to mild	836	284 (34.0)	
Moderate to severe	185	110 (59.5)	
Genito-urinary			
Sexual problems			<0.001
None to mild	865	308 (35.6)	
Moderate to severe	152	86 (56.6)	
Vaginal dryness			<0.001
None to mild	819	284 (34.7)	
Moderate to severe	202	110 (54.5)	

Results were analysed using Pearson's chi-square test and are shown as n (row %). Missing data ranged from 0.2% to 7.0%.

year after starting chemotherapy [39], possibly owing to cancer-related fatigue experienced by survivors [38]. Certain medications for breast cancer treatment have been previously found to correlate with sleep disturbances and insomnia [43] due to a wide range of side effects including hot flushes, vaginal dryness, and depression [43,44]. However, examples of these medications, such as tamoxifen and letrozole usage, were not significantly associated with poor sleep quality (data not shown) in our study. Additional studies, preferably with a longitudinal design, are needed to further elucidate the relationship between breast cancer history and sleep quality.

Unlike previous studies reporting significant associations between depression and/or anxiety symptoms and poor sleep [7,8,11–13,15–17], as well as vasomotor symptoms and poor sleep [7,8,10–14], our study observed no such relationship. A previous study reported no significant correlations between insomnia and depression and scores [45]. The density of rapid eye movement during sleep has been postulated to be a significant discriminator between patients with depression and those without in one study [46]. Objectively measured sleep might be helpful in further elucidating the relationship between depression and/or anxiety

Table 1b
Health conditions and objectively measured physical characteristics by sleep quality.

Characteristics	Total (n = 1094)	Poor sleep quality (PSQI >5) (n = 418, 38.2%)	P-value
Health conditions			
Diabetes			0.050
Yes	124	57 (46.0)	
No	952	351 (36.9)	
Hypertension			0.742
Yes	482	187 (38.8)	
No	595	225 (37.8)	
Depression and/or anxiety			0.850
Yes	183	71 (38.8)	
No	904	344 (38.1)	
Urinary incontinence			<0.001
Yes	526	231 (43.9)	
No	497	163 (32.8)	
Osteoporosis			0.800
Yes	117	46 (39.3)	
No	976	372 (38.1)	
Rheumatoid arthritis			0.069
Yes	109	50 (45.9)	
No	950	351 (36.9)	
Osteoarthritis			0.522
Yes	210	76 (36.2)	
No	837	323 (38.6)	
Heart conditions[a]			0.115
Yes	40	20 (50.0)	
No	1041	392 (37.7)	
Asthma			0.017
Yes	81	41 (50.6)	
No	1012	377 (37.3)	
Disability			<0.001
None to mild	1044	379 (36.3)	
Moderate to severe	50	39 (78.0)	
Breast cancer history			0.005
Yes	51	29 (56.9)	
No	1035	387 (37.4)	
Health conditions[b]			<0.001
≥3	250	118 (47.2)	
<3	655	224 (34.2)	
Objectively measured physical characteristics			
Body mass index, kg/m^2			0.683
Underweight, <18.5	58	21 (36.2)	
Normal, 18.5–22.9	455	166 (36.5)	
Overweight, 23.0–27.4	374	146 (39.0)	
Obese, ≥27.5	207	85 (41.1)	
Visceral adipose tissue, cm^2			0.160
Lowest	363	131 (36.1)	
Middle	363	132 (36.4)	
Highest	360	152 (42.2)	
Handgrip strength, kg			0.982
<18	243	93 (38.3)	
≥18	851	325 (38.2)	
Short physical performance battery			0.040
Low to moderate performance	180	81 (45.0)	
High performance	914	337 (36.9)	

Results were analysed using Pearson's chi-square test and are shown as n (row %). Missing data ranged from 0.1% to 17.3%.
[a] Heart conditions include angina, heart attack, congestive heart failure, and coronary bypass/angioplasty.
[b] Health conditions include diabetes, hypertension, depression and/or anxiety, urinary incontinence, osteoporosis, rheumatoid arthritis, osteoarthritis, heart conditions, asthma, disability, and breast cancer history.

Table 2
Comparison of PSQI components and global scores by ethnicity.

Component	Total (n = 1062)	Chinese (n = 897)	Malay (n = 59)	Indian (n = 106)	P-value
Subjective sleep quality	0.93 ± 0.72	0.92 ± 0.71	0.97 ± 0.83	0.95 ± 0.72	0.827
Sleep latency	0.83 ± 0.92	0.81 ± 0.90	1.05 ± 1.06	0.91 ± 0.99	0.095
Sleep duration	1.37 ± 1.05	1.36 ± 1.04	1.38 ± 1.12	1.42 ± 1.11	0.862
Habitual sleep efficiency	0.52 ± 0.88	0.51 ± 0.87	0.46 ± 0.80	0.61 ± 1.00	0.465
Sleep disturbances	1.18 ± 0.51	1.17 ± 0.49[a]	1.20 ± 0.55[a,b]	1.33 ± 0.58[b]	0.006
Daytime dysfunction	0.35 ± 0.55	0.33 ± 0.55[a]	0.54 ± 0.60[b]	0.40 ± 0.56[a,b]	0.009
PSQI global score	5.13 ± 3.03	5.02 ± 2.97[a]	6.00 ± 3.31[b]	5.58 ± 3.30[a,b]	0.015

Results were analysed using one-way ANOVA with Bonferroni post-hoc test for multiple comparisons and presented as mean ± SD. N = 32 were non-Chinese, non-Malay, and non-Indian ethnicity. Component scores range from 0 to 3, with 3 denoting severe difficulty. The seven component scores were added to calculate the global score, ranging from 0 to 21, with 21 indicating severe difficulty in all areas.
[a,b,c]Data in the same row with different superscripts are significantly different from one another between ethnic groups.

Table 3
Results of multivariable logistic regression analyses of factors associated with poor sleep quality, as denoted by aOR (95% CI).

Factors	Overall Cohort (n = 1094)
Demographic and lifestyle factors	
Age, years	
45-54	Reference
55-64	1.51 (0.99, 2.30)
≥65	1.32 (0.74, 2.38)
Ethnicity	
Chinese	Reference
Malay	1.59 (0.80, 3.13)
Indian	1.43 (0.80, 2.53)
Highest education level	
No formal or primary	1.76 (1.01, 3.05)
Pre-university	1.11 (0.72, 1.71)
University	Reference
Non-married	1.08 (0.71, 1.63)
Smokers	0.87 (0.27, 2.78)
Alcohol consumers	0.79 (0.30, 2.08)
Low physical activity	1.17 (0.86, 1.60)
Vitamin D deficient, ≤20 ng/ml	1.09 (0.74, 1.60)
Menopausal symptoms	
Menopausal status	
Premenopausal	1.09 (0.61, 1.93)
Perimenopausal	1.27 (0.77, 2.11)
Postmenopausal	Reference
Somatic	
Hot flushes[a]	1.39 (0.92, 2.12)
Heart discomfort[a]	1.25 (0.59, 2.64)
Joint or muscle discomfort[a]	1.23 (0.84, 1.79)
Psychological	
Irritability[a]	2.67 (1.56, 4.60)
Physical mental exhaustion[a]	1.48 (0.94, 2.33)
Genito-urinary	
Sexual problems[a]	1.22 (0.73, 2.02)
Vaginal dryness[a]	1.62 (1.03, 2.54)
Health conditions	
Diabetes	1.45 (0.86, 2.45)
Hypertension	0.91 (0.63, 1.31)
Depression and/or anxiety	0.77 (0.47, 1.26)
Urinary incontinence	1.53 (1.08, 2.17)
Osteoporosis	1.00 (0.59, 1.68)
Rheumatoid arthritis	0.90 (0.52, 1.57)
Osteoarthritis	0.77 (0.50, 1.18)
Heart conditions[b]	1.25 (0.54, 2.90)
Asthma	0.95 (0.49, 1.85)
Moderate or severe disability	2.99 (1.20, 7.44)
Breast cancer history	2.77 (1.36, 5.64)
≥3 health conditions[c]	1.15 (0.64, 2.05)
Objectively measured physical characteristics	
Body mass index, kg/m^2	
Underweight, <18.5	1.12 (0.51, 2.45)
Normal, 18.5–22.9	Reference
Overweight, 23.0–27.4	0.92 (0.60, 1.42)
Obese, ≥27.5	0.81 (0.43, 1.53)
Visceral adipose tissue, cm^2	
Lowest tertile	Reference
Middle tertile	0.85 (0.55, 1.31)
Highest tertile	1.21 (0.70, 2.11)
Handgrip strength <18 kg	0.79 (0.54, 1.15)
Low to moderate performance on SPPB	1.17 (0.76, 1.80)

Results were analysed using binary logistic regression and presented as aOR (95% CI).
[a] Moderate to severe compared to none or mild symptoms.
[b] Heart conditions include angina, heart attack, congestive heart failure, and coronary bypass/angioplasty.
[c] Health conditions include diabetes, hypertension, depression and/or anxiety, urinary incontinence, osteoporosis, rheumatoid arthritis, osteoarthritis, heart conditions, asthma, disability, and breast cancer history.

symptoms and poor sleep in our women. The lack of a significant association between hot flushes and poor sleep could be due to a lower proportion of women with hot flushes in our study (17%) compared to those observed in other cohorts (30%–58%) [8,12,14]. However, our findings concur with two previous studies among Asian midlife women [14,15,47]. Hot flush frequencies may be lower in warmer climates and in settings with high temperature variability [48] like tropical Singapore.

Our study uniquely examined individual components of the Menopausal Rating Scale and their associations with poor sleep quality. We found two menopausal symptoms, irritability and vaginal dryness, to be significantly associated with poor sleep. Vaginal dryness during sexual activity was significantly associated with increased sleep disturbances (aOR: 1.69, 95% CI: 1.24–2.30) among midlife women in a British study [49]. Since it was previously reported that around 85% of women experience menopausal symptoms during the perimenopausal phase [50], it will be of value to examine individual components of the MRS with poor sleep quality in future longitudinal studies.

Our findings agree with other studies that ethnic minorities tend to report poorer quality of sleep [4,7,10,51]. Malay and Indian women in our cohort reported greater daytime dysfunction and overall sleep quality, and increased sleep disturbances than Chinese women. This finding may be related to previous findings in Singapore of increased habitual snoring and breathing-related disorders among Indian and Malay vs Chinese women [52]. Differences in sleep quality among the various ethnicities might be explained by the higher prevalence of obesity and hypertension among Malays and Indians [52]. We too have reported higher body mass index among Malay and Indian women than in Chinese women [53].

Several limitations in our study merit comment. First, its cross-sectional design prevents causal inferences from observed associations between poor sleep quality and the factors studied. Second, the PSQI assesses subjective sleep quality, because it is based on self-reports and thus prone to errors and bias in recall. Nonetheless, while the gold standard for evaluating sleep disorders is polysomnography [54], subjective sleep measures may reveal an important subjective aspect of sleep not reflected by polysomnography [55], since it reflects how women perceive their own sleep quality. A third limitation is that we collected no data on factors like diet and caffeine intake. We did, however, measure a broad range of variables, including demographics and lifestyle choices such as smoking and physical activity, as well as health conditions and objectively measured physical characteristics.

Strengths of our study include its being the first in Singapore to examine factors for poor sleep quality in a cohort of midlife women. Sleep quality, as well as the health conditions we assessed, were based on validated questionnaires. Moreover, our cohort of women was ethnically heterogeneous, enabling us to observe differences among Chinese, Malay, and Indian women.

5. Conclusion

The prevalence of poor sleep quality observed among midlife women was higher than that reported among the general population of Singapore. The high prevalence might possibly be explained by midlife-specific conditions such as urinary incontinence, irritability, vaginal dryness, moderate to severe disability and a history of breast cancer. These finding suggests the need for improved sleep management in women with the above-mentioned conditions. Ethnic differences in sleep quality suggest that ethnically targeted interventions may warrant consideration. Longitudinal studies are required to confirm our findings.

CRediT authorship contribution statement

Beverly W.X. Wong: provided methodological inputs, performed statistical analysis, and wrote the manuscript. **Yiong Huak Chan:** provided methodological inputs and performed statistical analysis. **Michael S. Kramer:** provided methodological inputs and wrote the manuscript. **Inger Sundström-Poromaa:** provided methodological inputs and wrote the manuscript. **Susan Logan:** conceived and designed the study, provided methodological inputs, and wrote the manuscript. **Jane A. Cauley:** conceived and designed the study, provided methodological inputs, and wrote the manuscript. . **Eu-Leong Yong:** conceived and designed the study, provided methodological inputs, and wrote the manuscript. All authors have read and approved the final manuscript.

Funding

This study was partially funded by the Singapore National Medical Research Council Grant (Reference number: NMRC/CSA-SI/0010/2017) to EL Yong.

Declaration of competing interest

All authors declare that they have no competing interests.

Acknowledgements

We would like to thank our IWHP research participants for their time and participation in this study. We would like to express our thanks to Dr. Li Jun for grant management and procurement of study materials and to Ms. Tan Sze Yee for performing the DXA scans. We would also like to acknowledge and thank study coordinators Ms. Ho Kum Chue, Ms. Chua Seok Eng, and Ms. Poon Peng Cheng for helping with the data collection and logistics.

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