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BRIEF REPORT

Impact of sleep disturbances on employment and work productivity among midlife women in the US SWAN database: a brief report

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Abstract

Objective: Menopause is associated with an increased prevalence of sleep difficulties. We evaluated the economic burden of sleep disturbances among working midlife women.

Methods: This retrospective, longitudinal cohort study collected data from the US Study of Women's Health Across the Nation (SWAN) database of women age 42-52 years at enrollment. We assessed the association between sleep disturbances (trouble falling asleep, waking early, or nocturnal awakenings) and workplace productivity (employment [yes/no] and work hours/wk) for women who were employed at the baseline visit and had ≥1 follow-up visit. We estimated overall economic burden by multiplying changes in productivity by median age-specific hourly US wages. Each woman's data were compared from visit to visit and were excluded after the first observed unemployment. Regression analysis was used to estimate associations between changes in sleep and changes in workplace productivity while controlling for relevant characteristics that varied over time.

Results: The analysis included 2,489 working women (19,707 visits); 31% became unemployed during follow-up. Risk of unemployment was 31% higher for women with versus without new-onset sleep disturbances ($P = 0.0474$). Onset of sleep disturbances was associated with a 0.44-0.57 hours/wk reduction in work time (not significant). Using the more conservative reduction (0.44 h), sleep problems were associated with an annual loss of $517 to $524 per woman and $2.2 billion/yr in lost productivity among women age 42-64 nationwide.

Conclusions: New-onset sleep problems in midlife women are associated with significant increases in risk of unemployment and ~$2 billion/yr in lost productivity nationwide.

Key Words: Costs – Economics – Employment – Middle aged – Women – Work.

Video Summary: http://links.lww.com/MENO/A798.

Menopause is associated with an increased prevalence of sleep difficulties.[1-3] Vasomotor symptoms (VMS), especially night sweats, are a key risk factor for sleep difficulties and disorders,[2-6] although sleep disruptions also occur in menopausal women without VMS.[5,7] Sleep disturbances have been reported to reduce occupational function in the general population of workers[8-10] and specifically in symptomatic menopausal women.[11]

The objective of this analysis was to estimate the economic burden associated with sleep disturbances in midlife women. To accomplish this, we first estimated the association between reduced sleep quality and work-related outcomes (employment

and average paid hours worked per week) and then calculated the individual and national cost of this lost productivity.

METHODS
Data extraction and analysis
We conducted a retrospective analysis of the US Study of Women's Health Across the Nation (SWAN) database. SWAN is a longitudinal, epidemiologic cohort study that examined the health and menopausal transition of a multiracial/multiethnic group of midlife (42-52 yrs) women from seven sites across the United States.[12,13] SWAN survey data from baseline and the first 10 annual follow-up visits (1995-2008) are publicly available.[14]

For this analysis, we extracted data obtained from women who were working for pay at the time of their baseline visit. For each woman, we included data through the next visit after the one at which they first reported becoming unemployed, their last recorded visit in SWAN, or the final follow-up visit (visit 10), whichever came first. All data were anonymized in this noninterventional analysis; therefore, institutional review board review was not required.

For each visit, we classified a participant as having sleep difficulties if she reported trouble falling asleep, waking early, or sleep interruptions at least three times in the past 2 weeks. Because we were interested in whether sleep difficulties had an impact on employment, we wanted to rule out the converse—that is, sleep disturbances that may have been caused by employment insecurity.[15] To accomplish this, we used a lagged approach: for each visit (t), we identified whether the woman reported having had a sleep problem two visits prior (visit t−2) and/or one visit prior (visit t−1) and whether changes in employment had occurred during the interval from one visit prior (t−1) to the current visit (t), thereby limiting the analysis to sleep problems that preceded work productivity changes. For the primary analysis, we compared women with new-onset sleep disturbances (ie, women with no sleep disturbance at t−2 followed by sleep disturbance at t−1) with women who reported no sleep disturbances at either visit. The analysis sample was limited to women with nonmissing data for at least three consecutive visits.

Statistical analyses
We modeled time to first unemployment as a discrete-time Cox proportional hazards model estimated via complementary log-log regression, controlling for study visit, age at baseline, covariate levels measured at visit t−1, and differences in covariates from visit t−2 to visit t−1. Women who did not become unemployed were censored at their last available visit. We used regression modeling to estimate associations between changes in sleep quality and changes in hours worked while controlling for relevant patient characteristics. We analyzed hours worked using a linear regression model and, as a robustness check, repeated the analysis using a linear mixed regression model with a Toeplitz 1 error structure. The covariates and additional details of the methods

are described in the Supplemental Digital Content, http://links.lww.com/MENO/A797.

We calculated individual annual economic burden by determining the reduction in hours worked per week multiplied by women's median hourly wage in the fourth quarter of 2019 ($22.73 to $23.08 based on age category; from the US Bureau of Labor Statistics [BLS])[16] and by 52 weeks. We assumed that reduction in hours worked would last for 1 year. National annual economic burden was calculated using the number of women in the civilian population (48,574,800 women age 42-64, from BLS) multiplied by the labor force participation rate (67%, from BLS[17]), risk of new-onset sleep problem (calculated from the SWAN database), effect of sleep on hours worked, hourly wage in 2019 Q4 (from BLS[18]), and 52 weeks.

RESULTS
Analysis population
The SWAN database included 2,489 women with evidence of paid employment (19,707 total visits). The final analysis sample of women without missing values for unemployment consisted of 2,092 women with 11,557 visits. Demographic and socioeconomic variables over the observation period are shown in Table 1.

Impact of sleep disturbance on employment
Nearly one-third (793/2,489 [31%]) of the women became unemployed during the observation period (overall hazard of unemployment: 4.3%). Mean age when they first became unemployed was 50.8 (range: 43-63) years. The risk of unemployment was 31% higher for those with new-onset sleep disturbance compared with those without sleep disturbances (HR 1.31, 95% CI: 1.00-1.70; $P = 0.047$).

Cost of sleep disturbances in midlife women
Impact of sleep on work productivity
The analysis of hours worked was conducted using data from 1,774 women with 7,491 visits; at the baseline visit, the women were working a mean (SD) of 39.4 (11.12) hours/wk. Relative to no sleep disturbance, new-onset sleep disturbance was associated with incremental reductions of 0.57 hours (95% CI: −1.46 to 0.31 h) worked per week (2.05 vs 1.47 h, $P = 0.20$) in the linear regression model and 0.44 hours (95% CI: −1.23 to 0.35 h) worked per week (1.31 vs 0.87 h, $P = 0.28$) in the mixed linear regression model, which was used as a robustness check; these reductions were not statistically significant.

We calculated individual economic burden by multiplying the more conservative estimate of productivity loss (0.44 hours/wk) by women's median wages (~$23/h across age groups, based on BLS data[16]). New-onset sleep disturbance in midlife women resulted in $517 to $524 in lost work productivity per person per year (Table 1, Supplementary Digital Content 2, http://links.lww.com/MENO/A797). Multiplied across the 48.5 million women age 42 to 64 years in the United States,

TABLE 1. *Demographics and socioeconomic variables during the 10-year observation period for employed women aged 42 to 52 years at enrollment in the US SWAN Database[a]*

	Overall population (11,557 visits)	Subgroup with new-onset sleep disturbance[b] (1,516 visits)	Subgroup with no sleep disturbance (6,113 visits)
Age at baseline, mean (SD), yrs	45.81 (2.62)	45.85 (2.58)	45.72 (2.60)
Race			
White, non-Hispanic	6,337 (55)	876 (58)	3,067 (50)
Black	2,677 (23)	354 (23)	1,429 (23)
Chinese/Chinese-American	1,165 (10)	132 (8.7)	742 (12)
Japanese/Japanese-American	1,191 (10)	136 (9.0)	742 (12)
Hispanic	187 (1.6)	18 (1.2)	133 (2.2)
Smoker	1,406 (12)	181 (12)	747 (12)
Comorbidity count[c]			
0	5,413 (47)	655 (43)	3,299 (54)
1	3,441 (30)	468 (31)	1,713 (28)
2	1,695 (15)	243 (16)	735 (12)
≥3	1,008 (8.7)	150 (9.9)	366 (6.0)
Marital status			
Currently married	7,574 (66)	978 (65)	4,083 (67)
Formerly married	2,413 (21)	335 (22)	1,192 (19)
Single/Never married	1,570 (14)	203 (13)	838 (14)
Number of children in household			
0	8,540 (74)	1,155 (76)	4,347 (71)
1	1,709 (15)	211 (14)	970 (16)
2	947 (8.2)	113 (7.5)	580 (9.5)
3	286 (2.5)	24 (1.6)	182 (3.0)
≥4	75 (0.6)	13 (0.9)	34 (0.6)
Household annual income			
<$20,000	457 (4.0)	56 (3.7)	189 (3.1)
$20,000 to <$50,000	3,100 (27)	426 (28)	1,597 (26)
$50,000 to <$100,000	4,246 (37)	522 (34)	2,340 (38)
≥$100,000	3,427 (30)	468 (31)	1,801 (29)
Missing	327 (2.8)	44 (2.9)	186 (3.0)
CES-D, mean (SD) score across all visits	7.85 (7.88)	9.65 (8.55)	6.09 (6.46)
Poor work conditions[d]	4,674 (40)	661 (44)	2,243 (37)
Higher workload[e]	4,228 (37)	561 (37)	2,102 (34)
Overnight hospitalization since last visit	671 (5.8)	116 (7.7)	254 (4.2)
Other socioeconomic factors			
Financial problems	2,620 (23)	381 (25)	1,162 (19)
Relationship problems	4,234 (37)	594 (39)	2,001 (33)
Legal problems	1,234 (11)	197 (13)	538 (8.8)
Family illness	2,900 (25)	437 (29)	1,330 (22)

CES-D, Center for Epidemiologic Studies Depression Scale; SD, standard deviation; SWAN, Study of Women's Health Across the Nation; US, United States.
[a]Except where specified, outcomes are reported as number (%) of visits.
[b]For each visit (t), we classified a participant as having sleep difficulties if she reported trouble falling asleep, waking early, or sleep interruptions at least three times in the past 2 weeks. Sleep disturbances were considered new-onset if they were present at the preceding visit (t-1) but not at the visit prior to that (t-2).
[c]The count of comorbidities included 10 conditions: diabetes, hypertension, cholesterol, migraines, stroke, arthritis, heart attack, angina, cancer, and obesity (body mass index [BMI] >30 kg/m^2).
[d]A positive response for poor work conditions was recorded if the woman reported at the time of the visit that she was having trouble with her boss or worsening work conditions.
[e]A positive response for higher workload was recorded if the woman indicated at the time of the visit that she had taken on a greatly increased workload at her job.

67% of whom are employed, this translates into nearly $2.2 billion in lost productivity associated with new-onset sleep disturbances. (For a breakdown by age category, see Table 2, Supplementary Digital Content 2, http://links.lww.com/MENO/A797).

DISCUSSION

To our knowledge, this is the first analysis showing that new-onset sleep disturbances in midlife women may be associated with job loss. It also provides a current estimate of the magnitude of productivity loss and related economic costs associated with sleep disturbances in this population.

Our results build on previous reports indicating that sleep disturbances contribute to reduced occupational function and productivity loss in the general population of workers. An analysis based on a large Kansas state employee wellness program database ($N = 11,698$) found that higher levels of difficulty sleeping were associated with more absenteeism and lower self-ratings of work performance.[8] In an assessment of data from 598,676 adults employed in multiple industries in the United States included in the StayWell health risk assessment,[9,19] employees who averaged ≤5 hours of sleep per night lost a mean of 2.22 days of work per year compared with 1.48 days lost by those who averaged 8 hours of sleep per night. A survey of 4,188 workers from four US companies

found insomnia and insufficient sleep to be associated with 6.1% and 5.5% productivity losses, respectively, as well as associated impairments in time management, attention, decision-making, memory, and motivation at work.[10] The per-employee estimated work productivity losses averaged $3,156, $2,796, and $2,319 for insomnia, insufficient sleep, and sleep disturbances, respectively, at a cost of $54 million annually (in 2007 US$) across the four companies.

Few other large studies have evaluated the impact of sleep disturbance specifically in midlife, menopausal, or postmenopausal women. One exception is an analysis by Bolge et al[11] of data from 5,781 symptomatic menopausal women in the 2005 US National Health and Wellness Survey. Women experiencing chronic insomnia resulting from nighttime awakenings had a 16% larger work productivity loss compared with women without chronic insomnia ($P < 0.001$). Presenteeism (impairment at work) accounted for much of this reduction. In our analysis, productivity loss based on hours worked (which does not include presenteeism) was approximately 40% to 50% larger in the new-onset sleep disturbance group than in those without sleep disturbances, although the difference was not statistically significant.

Our analysis looked at the impact of sleep disturbances on midlife women irrespective of the presence or severity of VMS, which are widely recognized to affect sleep.[2-6] Hormone and nonhormone treatments for VMS have been shown to improve sleep outcomes.[20-25] Therefore, it is possible that by reducing VMS-related sleep disruptions, these treatments could help minimize sleep impacts on occupational function and productivity among menopausal women; however, this requires confirmation in future investigations as we did not evaluate the direct effects of VMS or treatment on employment or productivity. Some sleep disturbances in menopausal women occur independently of VMS,[5,7] so it may be necessary to address sleep problems directly to minimize impact on occupational function.

There are a number of limitations to our analysis. The SWAN database is not a national probability sample and is subject to selection bias. The SWAN database does not reliably indicate reason for or duration of unemployment, and relies on self-reported data that may lead to measurement error or interindividual variations in subjective assessment of sleep quality. Validated sleep scales were not used to capture sleep disturbances. While the lagged approach (described in Methods) allowed us to focus on sleep changes that preceded employment changes, thereby minimizing the effects of labor changes on sleep changes, this approach is not perfect, as it is possible that women lost and gained jobs between visits in the SWAN database. As with any observational analysis, we are unable to account for unobserved time-varying confounding factors.

CONCLUSIONS

Compared with women who consistently had no sleep problems, women with a new-onset sleep problem had a 31% greater chance of becoming unemployed and lost nearly a half hour per week of work time. Nationwide, lost productivity after onset of sleep disruptions is associated with $2.2 billion among women age 42 to 64 years.

REFERENCES

1. Kravitz HM, Ganz PA, Bromberger J, Powell LH, Sutton-Tyrrell K, Meyer PM. Sleep difficulty in women at midlife: a community survey of sleep and the menopausal transition. *Menopause* 2003;10:19-28.
2. Kravitz HM, Zhao X, Bromberger JT, et al. Sleep disturbance during the menopausal transition in a multi-ethnic community sample of women. *Sleep* 2008;31:979-990.
3. Lampio L, Polo-Kantola P, Polo O, Kauko T, Aittokallio J, Saaresranta T. Sleep in midlife women: effects of menopause, vasomotor symptoms, and depressive symptoms. *Menopause* 2014;21:1217-1224.
4. Thurston RC, Santoro N, Matthews KA. Are vasomotor symptoms associated with sleep characteristics among symptomatic midlife women? Comparisons of self-report and objective measures. *Menopause* 2012;19:742-748.
5. Freeman EW, Sammel MD, Gross SA, Pien GW. Poor sleep in relation to natural menopause: a population-based 14-year follow-up of midlife women. *Menopause* 2015;22:719-726.
6. Gao CC, Kapoor E, Lipford MC, et al. Association of vasomotor symptoms and sleep apnea risk in midlife women. *Menopause* 2018;25:391-398.
7. Hung HC, Lu FH, Ou HY, Wu JS, Yang YC, Chang CJ. Menopause is associated with self-reported poor sleep quality in women without vasomotor symptoms. *Menopause* 2014;21:834-839.
8. Hui SK, Grandner MA. Trouble sleeping associated with lower work performance and greater health care costs: longitudinal data from Kansas State Employee Wellness Program. *J Occup Environ Med* 2015;57:1031-1038.
9. Gingerich SB, Seaverson ELD, Anderson DR. Association between sleep and productivity loss among 598 676 employees from multiple industries. *Am J Health Promot* 2018;32:1091-1094.
10. Rosekind MR, Gregory KB, Mallis MM, Brandt SL, Seal B, Lerner D. The cost of poor sleep: workplace productivity loss and associated costs. *J Occup Environ Med* 2010;52:91-98.
11. Bolge SC, Balkrishnan R, Kannan H, Seal B, Drake CL. Burden associated with chronic sleep maintenance insomnia characterized by nighttime awakenings among women with menopausal symptoms. *Menopause* 2010;17:80-86.
12. Sowers M, Crawford S, Sternfeld B. Design, survey, sampling and recruitment methods of SWAN: a multi-center, multi-ethnic, community-based cohort study of women and the menopausal transition. In: Lobo RA, Kelsey J, Marcus R, editors. *Menopause: Biology and Pathobiology*. San Diego, CA: Academic Press; 2000. pp. 175-188.
13. Study of Women's Health Across the Nation (SWAN). About SWAN. Available at: https://www.swanstudy.org/about/about-swan/. Accessed March 5, 2021.
14. Study of Women's Health Across the Nation (SWAN). Data Access. Available at: https://www.swanstudy.org/swan-research/data-access/. Accessed March 5, 2021.
15. Mai QD, Hill TD, Vila-Henninger L, Grandner MA. Employment insecurity and sleep disturbance: evidence from 31 European countries. *J Sleep Res* 2019;28:e12763.
16. U.S. Bureau of Labor Statistics. Usual Weekly Earnings of Wage and Salary Workers News Release. Available at: https://www.bls.gov/news.-release/archives/wkyeng_01172020.htm. Accessed January 26, 2021.
17. U.S. Bureau of Labor Statistics. Employment status of the civilian noninstitutional population by age, sex, and race. Available at: https://www.bls.gov/cps/cpsaat03.htm. Accessed January 26, 2021.
18. Economic News Release [Table 3]. Median usual weekly earnings of full-time wage and salary workers by age, race, Hispanic or Latino ethnicity, and sex, second quarter 2020 averages, not seasonally adjusted. Available at: https://www.bls.gov/news.release/wkyeng.t03.htm. Accessed January 26, 2021.

19. Smith KW, McKinlay SM, Thorington BD. The validity of health risk appraisal instruments for assessing coronary heart disease risk. *Am J Public Health* 1987;77:419-424.

20. Cintron D, Lipford M, Larrea-Mantilla L, et al. Efficacy of menopausal hormone therapy on sleep quality: systematic review and meta-analysis. *Endocrine* 2017;55:702-711.

21. Mirkin S, Graham S, Revicki DA, Bender RH, Bernick B, Constantine GD. Relationship between vasomotor symptom improvements and quality of life and sleep outcomes in menopausal women treated with oral, combined 17β-estradiol/progesterone. *Menopause* 2019;26:637-642.

22. Pinkerton JV, Abraham L, Bushmakin AG, Cappelleri JC, Komm BS. Relationship between changes in vasomotor symptoms and changes in menopause-specific quality of life and sleep parameters. *Menopause* 2016;23:1060-1066.

23. Pinkerton JV, Joffe H, Kazempour K, Mekonnen H, Bhaskar S, Lippman J. Low-dose paroxetine (7.5 mg) improves sleep in women with vasomotor symptoms associated with menopause. *Menopause* 2015;22:50-58.

24. Depypere H, Timmerman D, Donders G, et al. Treatment of menopausal vasomotor symptoms with fezolinetant, a neurokinin 3 receptor antagonist: a phase 2a trial. *J Clin Endocrinol Metab* 2019;104:5893-5905.

25. Ensrud KE, Joffe H, Guthrie KA, et al. Effect of escitalopram on insomnia symptoms and subjective sleep quality in healthy perimenopausal and postmenopausal women with hot flashes: a randomized controlled trial. *Menopause* 2012;19:848-855.