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

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) 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.
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.\textsuperscript{12,13} SWAN survey data from baseline and the first 10 annual follow-up visits (1995-2008) are publicly available.\textsuperscript{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.\textsuperscript{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])\textsuperscript{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\textsuperscript{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\textsuperscript{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\textsuperscript{19}). 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,
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. In an assessment of data from 598,676 adults employed in multiple industries in the United States included in the StayWell health risk assessment, 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. 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 al11 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. 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.

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