# Supplemental DIGITAL CONTENT

**Impact of Sleep Disturbances on Employment and Work Productivity Among Midlife Women in the US SWAN Database: A Brief Report**

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# Supplemental DIGITAL CONTENT

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## Supplemental Digital Content 1. Additional Methods

### Definition of Employment Status

As noted in the article, the study was based on a secondary analysis of data from the multisite, longitudinal, epidemiologic SWAN database and the analysis was limited to data from women who reported paid employment at the baseline visit and at least 1 follow-up visit. Employment status (yes/no) was binary indicator for whether a woman was working based on whether she reported (a) being employed for pay (SWAN variable name EMPLYPA), (b) working for pay in the past 2 weeks (JOB), or (c) having positive hours worked for pay (HOURSPA). Because the 3 constituent variables were collected on different schedules and sometimes conflicted, a woman was coded as working based on any evidence of working. A woman was coded as unemployed if she actively responded as not working.

### Covariates

Baseline covariates included age at baseline visit (42-52 years) and study visit number. Covariates with little to no within-person variation over time included race, smoking status, comorbidity count (0, 1, 2, ≥3), marital status (currently married, formerly married, or single/never married), number of children in the household (0, 1, 2, 3, ≥4), and household income category ($0 to <$20K, $20K to <$50K, $50K to <$100K, ≥$100K).

 Covariates that may have varied substantially within person over time included Center for Epidemiologic Studies - Depression Scale (CES-D) score and binary indicators for 7 self-reported stressors (poor work conditions, higher workload, overnight hospital stay, financial problems, relationship problems, legal problems, and family illness). The count of comorbidities included 10 conditions: diabetes, hypertension, cholesterol, migraines, stroke, arthritis, heart attack, angina, cancer, obesity (body mass index [BMI] >30). Number of children in the household and the height and weight components of BMI were imputed via last observation carried forward. Comorbidities not collected at the baseline visit were imputed with the values from the first follow-up visit.

Descriptive statistics were calculated for all covariates stratified by level of exposure, and statistical tests of the equality of covariate values across exposure levels were conducted, including analysis of variance for equality of means for continuous covariates, and χ2 test for categorical covariates.

### Quantifying Hours Worked

Using the SWAN data, a regression analysis was conducted to assess the impact of change in any sleep problem from visit t‒2 to visit t‒1 on the number of hours worked as reported at visit t. Hours worked was a continuous measure of the number of hours a woman reported working for pay per week and was imputed as the midpoint of each range (1‒10, 11‒19, 20‒34, 35‒40, 41‒60), except for zero (unemployed) and the top-coded range (>60), which took the value 61 hours.

The change in overall hours worked (as measured from visit t−1 to visit t) in the same sample was modeled using a lagged first-differences model specification estimated via linear regression with the variance-covariance matrix adjusted to be made robust to heteroskedasticity and to account for multiple visits per respondent.1 Time-invariant covariates were controlled for via the first-differencing (ie, subtracting values at t‒1 from those at t) while the 8 covariates that exhibited within-person change over time (CES-D and the 7 indicators for stressors) were adjusted for in the model specification as changes from visit t‒2 to visit t‒1. As a robustness check, these models were also estimated as a mixed linear regression model with a Toeplitz 1 error structure to account for the serial correlation in error terms between adjacent visits.2

*Handling of Missing Data*

Missing data for the outcome number of children in household were imputed using last observation carried forward (LOCF). All other missing data were handled via listwise deletion for all samples.

**References**

1. Wooldridge JM. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press; 2010.

2. Allison PD. Asymmetric fixed-effects models for panel data. Socius. 2019;5:1-12.

## Supplemental Digital Content 2. Calculations of Individual and National Economic Burden

**Table 1. Individual Economic Burden (US$) Associated With New-Onset Sleep Disturbance in Women Aged 35‒64 Years**

|  |  |  |  |
| --- | --- | --- | --- |
| **Age Category, Years** | **Reduction in Hours Worked Per Weeka** | **Median Hourly Wage (2019 Q4 data)b** | **Annual Economic Burdenc** |
| 35‒44 | 0.4371 | $23.075 | $524 |
| 45‒54 | 0.4371 | $22.725 | $517 |
| 55‒64 | 0.4371 | $23.05 | $524 |

aRepresents the unrounded result from our SWAN database analysis.

bMedian hourly wage calculated as median weekly wage (from the Bureau of Labor Statistics1) divided by 40.

cAnnual economic burden calculated as reduction in hours worked per week multiplied by median hourly wage and 52.

Q4, fourth quarter; SWAN, Study of Women’s Health Across the Nation; US, United States.

**Table 2. National Economic Burden (US$) Associated With New-Onset Sleep Disturbance in Women Aged 42‒64 Years**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Age Category, Years** | **Number of Women in US Civilian Populationa** | **Labor Force Participation Ratea** | **Risk of New-Onset Sleep Problemb** | **Annual Economic Burden, Millionsc** |
| 42‒44d | 5,998,800 | 74% | 0.130 | $303 |
| 45‒49 | 10,293,000 | 75% | 0.126 | $506 |
| 50‒54 | 10,377,000 | 72% | 0.140 | $539 |
| 55‒59 | 11,135,000 | 65% | 0.139 | $528 |
| 60‒64 | 10,771,000 | 50% | 0.104 | $296 |
| **Total: 42‒64** | **48,574,800** | **67%** | **—** | **$2171** |

aBased on 2019 data from the Bureau of Labor Statistics.2

bThe sample of 15,354 person-visit observations in SWAN that had nonmissing information on sleep problems for the prior and current visit was used to calculate the proportion with onset of a sleep problem (transition from none to at least 1) to estimate risk of new-onset sleep problem. 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 3 times in the past 2 weeks. Sleep disturbances were considered new-onset if they were present at the preceding visit (t-1) but not the visit prior to that (t-2).

cAnnual economic burden calculated as number of women in the civilian population multiplied by the labor force participation rate, risk of sleep problem, effect of sleep on hours worked, hourly wage, and 52 weeks. (See Table 1, Supplementary Digital Content for hourly wage and effect of sleep on hours worked by age group.)

dThe 40 to 44 years age group was multiplied by 60% to adjust to 42 to 44 years, assuming a uniform population distribution across years of age.

SWAN, Study of Women’s Health Across the Nation; US, United States.

**References**

1. 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.

2. 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.