SLEEPJ, 2019, 1–10

doi: 10.1093/sleep/zsz109
Advance Access Publication Date: 7 May 2019
Original Article

ORIGINAL ARTICLE

Does removal of work stress explain improved sleep following retirement? The Finnish Retirement and Aging study

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Abstract

Study Objectives: Relief from work stress has been hypothesized to explain improvements in sleep duration and quality following retirement, but this has not been confirmed with longitudinal studies. By using repeat sleep data, we examined the role of removal of work-related stressors in changes in sleep at retirement.

Methods: The study population consisted of 2,053 participants from the Finnish Retirement and Aging study. Participants' sleep duration, sleep difficulties (difficulties falling asleep, difficulties maintaining sleep, waking up too early in the morning, nonrestorative sleep), daytime tiredness, and sleep loss due to worry were assessed using surveys conducted once a year before and after retirement (average number of repeat surveys 3.5 [range 2–5] per participant). We used Poisson regression with generalized estimating equations to examine the associations between work-related stressors (job strain, low work time control, effort–reward imbalance, and organizational injustice) and changes in sleep at retirement.

Results: An increase in sleep duration and decrease in waking up too early in the morning, nonrestorative sleep, daytime tiredness, and sleep loss due to worry were observed shortly after retirement. No systematic associations across the work-related stressors and changes in sleep characteristics were observed. Higher number of work-related stressors before retirement was not associated with a greater magnitude of favorable changes in any of the postretirement sleep characteristics investigated.

Conclusions: This longitudinal study suggests that perceived sleep improves shortly after retirement and that these changes are mainly driven by factors other than relief from work stress.

Statement of Significance

We examined the role of diminishing work stress in improvements in sleep following retirement using annual sleep measurements. Sleep duration increased and the prevalence of waking up too early in the morning, nonrestorative sleep, daytime tiredness, and sleep loss due to worry decreased shortly or immediately after retirement. However, no systematic patterns of associations between either the individual work-related stressors or number of different work-related stressors and changes in sleep were observed. These results suggest that the changes in sleep following retirement are mainly driven by factors other than the removal of work-related stressors. Future longitudinal studies with objective sleep measurements could increase the understanding of the changes in amount, quality, and timing of sleep in relation to retirement transition.

Key words: aging; sleep duration; sleep difficulties; daytime tiredness; work-related psychosocial factors; work stress; retirement

Submitted: 4 September, 2018; **Revised:** 20 March, 2019

Introduction

Retirement from work has recently been reported to be associated with sleeping more [1, 2], as well as experiencing fewer sleep difficulties [3–5], and less mental and physical fatigue [6] after retirement. These favorable changes in sleep have been hypothesized to partly result from the removal of work-related stressors after retirement [3, 5–7]. This hypothesis is supported by the association observed between psychosocial stress at work (such as high work demands, low job control, and imbalance between effort and reward at work) and poor sleep quality [8–10] and its correlates, such as fatigue, depression and poor self-rated health [6, 7]. Studies of preretirement risk factors have found that high psychological demands at work have been associated with reductions in sleep disturbances after retirement [3, 5]. Some work characteristics, such as low control over working hours, may result in sleep of inadequate length or quality if sleep timings are dominated by working hours. After retirement, the pressure to sleep at fixed times is removed, which may result in longer sleep duration and better quality of sleep.

In previous studies examining the changes in sleep around retirement, the interval between the measurements around the transition to retirement has ranged from 1 to 4 years [1–3, 5]. Shorter measurement intervals instead of relatively long measurement intervals around retirement could help to detect also brief or temporary changes in sleep as well as to identify factors driving these changes. After retirement, working hours no longer determine sleep timings and there are more possibilities to acquire more sleep of adequate amount and quality. It could be hypothesized that any changes in sleep would take place soon after retirement as these changes in the daily schedule and the removal of work stress would occur immediately following retirement. However, the exact timing of when changes in sleep duration and sleep difficulties take place has remained unclear.

Of the few studies that have examined changes in sleep shortly after retirement [1, 3, 6], only one studied work-related stressors and changes in sleep [3]. In that study, a relatively crude measurement of sleep (i.e. a single survey question about the occurrence of sleep disturbances during the past 12 months [3]) was used. We have previously observed that different types of sleep difficulties have different trends around retirement, specifically decreases in early morning awakenings and nonrestorative sleep are substantial whereas little change occurs in difficulties falling asleep and maintaining sleep after retirement [5]. Thus, it is important to examine changes in different types of sleep difficulties and the mechanisms driving these changes, such as the removal of work stress. However, we are not aware of previous studies on, for example, relief from work-related stressors and changes in sleep loss due to worry during the transition to retirement. Finally, to the best of our knowledge, no previous studies have examined whether changes in sleep depend on whether a person is exposed to multiple different work-related stressors, although this would allow to estimate whether a dose–response relationship exists for the work stress-sleep change association [11].

To address some of these limitations, this study was set up to examine whether removal of work-related stressors is associated with improvement in various sleep characteristics following retirement. We examined the sleep changes in relation to the individual work-related stressors and number of preretirement work-related stressors. To capture possible sleep parameter-specific associations, we focused on sleep duration, four types of sleep difficulties (difficulties falling asleep, difficulties maintaining sleep, waking up too early in the morning, and nonrestorative sleep), daytime tiredness, and sleep loss due to worry using repeated survey measurements around the transition to statutory retirement.

Methods

Study Population

The study population consisted of participants of the Finnish Retirement and Aging (FIREA) study, an ongoing longitudinal cohort study of older Finnish adults established in 2013 [12]. The eligible population for the FIREA study cohort included all public sector employees whose statutory retirement date was set between 2014 and 2019 and who were working either in one of the 27 municipalities in Southwest Finland or in one of the selected nine cities or five hospital districts around Finland in 2012. Participants were contacted by sending them a questionnaire 18 months before their estimated retirement date, which was obtained from the pension insurance institute for the municipal sector in Finland (Keva). Thereafter, questionnaires were sent to the participants annually, at least four times in total. The FIREA study was conducted in line with the Declaration of Helsinki, and approved by the Ethics Committee of Hospital District of Southwest Finland.

Of the FIREA cohort members, 6,679 (response rate 63%) had responded to at least one survey by the end of December 2017. Of these respondents, 5,076 were still working when they responded to the first survey. Of these, 2,082 participants (41%) had responded to two consecutive surveys around retirement, one survey before and one after retirement between 2013 and 2017. To be included in this study, the participants had to have information on at least one of the sleep measurements (sleep duration, any of the four types of sleep difficulties, daytime tiredness, or sleep loss due to worry) from the questionnaires immediately before and after the transition to statutory retirement, resulting in an analytical sample of 2,053 persons. This sample was used to examine the overall changes in sleep characteristics during the retirement transition.

Questions related to work-related stressors were not included in FIREA study until the 2016 survey, and therefore, data for at least one work-related stressor was available only for 294 participants. Thus, for the analyses related to work-related stressors and changes in sleep characteristics, we used additional information from another cohort study, the Finnish Public Sector (FPS) study [2, 5] in which most of the participants had participated when still at work. FPS is a large ongoing cohort study collecting data on psychosocial work characteristics by biennial surveys among public sector employees in Finland. Of the remaining participants, 1,526 (87%) gave permission to link their information from the FPS surveys to the information from the FIREA surveys. In the analyses regarding the work-related stressors, the number of participants ranged from 1,555 to 1,820 depending on the number of participants who had responded to the questions related to each work-related stressor.

Assessment of Retirement

The actual retirement date was self-reported. The participants' retirement took place between 2013 and 2017. The statutory

retirement age among FIREA cohort members is generally 63 years. However, some employees have been able to keep their earlier retirement ages from a previous pension act in which pension ages were below 63 years in some occupations (e.g. 60 years for primary school teachers).

Assessment of Sleep

Sleep duration was measured in each repeated survey wave by asking participants to estimate how many hours they usually sleep per 24 h and to choose one of the following response alternatives: 6 h or less, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, and 10 h or more. In the analyses, these response alternatives were counted as hours, and the extremes of the scale, 5.5 and 10.5 hours, were assigned to categories "6 hours or less" and "10 hours or more," respectively.

Sleep difficulties were measured with the Jenkins Sleep Problem Scale [13], including four items: difficulties falling asleep, difficulties maintaining sleep during the night (i.e. "waking up several times per night"), waking up too early in the morning (i.e. "having troubles staying asleep (including too early awakening)"), and nonrestorative sleep (i.e. "waking up after the usual amount of sleep feeling tired and worn out"). Participants were asked to estimate how often each of these difficulties had occurred during the previous 4 weeks (never, one–three nights per month, one night per week, two–four nights per week, five–six nights per week, and nearly every night). The four types of sleep difficulties were examined individually and responses were dichotomized so that the participant was considered to have a sleep difficulty if the frequency was higher than four nights per week.

Daytime tiredness was measured by asking participants "Compared to other people of your age, are you usually more tired during the daytime?". Participants chose one of the four response alternatives: (1) "Yes, almost always," (2) "Yes, often (at least weekly)," (3) "No," or (4) "Cannot say." Daytime tiredness was dichotomized into yes (response scores 1 and 2) and no (score 3), and those who were indecisive (score 4) were not included in the analysis (n = 373 in the measurement immediately before retirement and n = 358 in the measurement immediately after retirement).

Sleep loss due to worry was assessed with a single item from the 12-item version of General Health Questionnaire [14], in which participants were asked "Have you recently lost much sleep due to worry?". Participants were asked to think about the past few weeks when responding to the question and to choose one of the four response alternatives: (1) "Not at all," (2) "No more than usual," (3) "Rather more than usual," and (4) "Much more than usual." Sleep loss due to worry was dichotomized into no (response scores 1 and 2) and yes (response scores 3 and 4).

Assessment of Moderators: Work-related Stressors

Information on work-related stressors (job strain, work time control, effort–reward imbalance, and organizational injustice) was obtained from both the FIREA questionnaires (n = 294) and the FPS questionnaires (n = 1,526) using identical questions. For the analyses, we used information from the last questionnaire the participants completed before retirement (either FIREA or FPS). The distance from the last measurement before retirement to the retirement date was on average 6 months in the FIREA study and 1 year and 7 months in the FPS study.

Job strain was assessed with nine items measuring job control and five items measuring job demands derived from the Job Content Questionnaire [15, 16]. All items were evaluated on a 5-point Likert-type scale ranging from 1 (totally agree) to 5 (totally disagree) and the means of the scores on these items represent the individual levels of job demands and job control. The presence of job strain was defined as having high demands (above median, i.e. 3.33) and a low control (below median, i.e. 3.76) score based on the year 2012 FPS survey cutoff points. Job strain was also used as a continuous variable, in which case the score was calculated for each respondent by subtracting the mean of the nine job control scores from the mean of the five job demand score with higher scores indicating higher job strain.

Work time control was measured by asking participants to evaluate on a scale from 1 (very little) to 5 (very much) how much they could influence the following aspects of their working time: length of a workday, the starting and ending times of a workday, the taking of breaks during the workday, the handling of private matters during the workday, the scheduling of work shifts, the scheduling of vacations and paid days off, and the taking of unpaid leave [17]. The lowest quartile of the work time control scores was set to indicate exposure to low work time control whereas the remaining three quartiles were set as nonexposed. Work time control was also used as a continuous variable, in which case the mean of the scores was reverted, and thus, higher scores indicated lower work time control.

Effort–reward imbalance was measured with one item concerning effort and three items concerning rewards adapted from the standard 10-item scale by Siegrist [18–20]. Each of the items were evaluated using a 5-point scale from 1 (very little) to 5 (very much) and to form the variable for effort–reward imbalance, we computed the ratio of the effort score and the mean of the reward scores (effort–reward imbalance = effort score/mean score of reward items). This score was used when effort–reward imbalance was used as a continuous variable. When used as a categorical variable, the highest quartile of effort–reward imbalance scores was set to indicate exposure to effort–reward imbalance whereas the remaining three quartiles were set as nonexposed.

Organizational injustice was assessed with six items measuring relational justice and seven items measuring procedural justice adopted from the standardized Moorman's scale [21, 22]. All items were evaluated on a 5-point Likert-type scale ranging from 1 (totally agree) to 5 (totally disagree). Means of the scores on these items were calculated to create individual scores for relational justice and procedural justice and the means of these two components were used to calculate the total score for organizational justice. The lowest quartile of organizational justice scores was set to indicate exposure to organizational injustice whereas the remaining three quartiles were set as nonexposed. Organizational justice was also used as a continuous variable, in which case the mean of the item scores was reverted, and thus, higher scores indicated higher organizational injustice.

Because work-related stressors tend to cluster in the same individuals [11], we also created a summary variable indicating the *number of work-related stressors* (job strain, effort–reward imbalance, work time control, or organizational injustice) the participants were exposed to. The participants were categorized

into having had "0," "1," or "2 or more" work-related stressors before retirement.

Assessment of Covariates

For the covariates, we chose factors that may have been associated with either sleep or work stress before retirement, as we wanted to control for the possible changes in sleep being due to preretirement differences between the participants. The participants' year of birth, gender, and occupational title were obtained from the pension insurance institute for the municipal sector in Finland (Keva). The occupational titles of the last occupation preceding retirement were coded according to the Standard Classification of Occupations 2001 by Statistics Finland [23] and further categorized into three groups: upper-grade nonmanual workers, lower-grade nonmanual workers, and manual workers. Information on health behaviors and health-related factors was obtained from the last FIREA questionnaire preceding retirement. Physical activity was assessed with reports on average weekly hours of leisure-time physical activity (including commuting) within previous year in walking, brisk walking, jogging, and running, or their equivalent activities [24]. Weekly physical activity was expressed in metabolic equivalent hours. Alcohol use was based on habitual frequencies of beer, wine, and spirits consumption and expressed as grams of alcohol per week. Body mass index (BMI) was calculated based on body weight and height (kg/m^2). Self-rated health was assessed with a 5-point scale (1 = good … 5 = poor), and dichotomized into good (response scores 1 and 2) and suboptimal (scores 3–5).

Statistical Analyses

To define the timing of the questionnaires in relation to retirement, we calculated a distance in days from the exact retirement dates reported by the participants to each date when the participant had filled in the questionnaire. The data were then centered around the exact retirement date and the distance to retirement was divided into time points with 3-month intervals. For example, those in the –3 months point had answered to the questionnaire approximately 3 months (range: 1.5–4.5 months) before their exact retirement date and those in the time point 0 somewhere between 1.5 months before and 1.5 months after their retirement date. Because measurements were conducted once a year, each participant has not contributed to all time points around retirement, but instead, for example, to time points –18 months, –6 months, +6 months, and +18 months. On average, participants had 3.5 (range: 2–5) measurements around retirement.

The level of the sleep characteristics is illustrated for each 3-month period before and after retirement transition. Linear regression analyses with generalized estimating equations (GEE) were used to calculate unadjusted means of sleep duration and their 95% confidence intervals (CIs) and the results are presented in hours and minutes by 3-month intervals. For all the other sleep characteristics, we calculated unadjusted prevalence estimates and their 95% CIs by 3-month intervals around retirement by using Poisson regression analyses with the GEE model. The GEE model controls for the intraindividual correlation between repeated measurements. The model uses an exchangeable correlation structure and is not sensitive to measurements that are missing at random [25, 26].

To examine changes in sleep measurements during retirement transition, we compared each participant's first measurement after retirement to their last measurement before retirement. The results for sleep duration were calculated using linear regression analysis with GEE models and are provided as a mean change and its 95% CIs, and the results for the other sleep characteristics were calculated using Poisson regression with GEE models and are provided as risk ratios (RRs) and their 95% CIs. Two models were created: Model 1, adjusted for age and gender, and Model 2, which was additionally adjusted for occupational status, physical activity, alcohol use, BMI, and self-rated health.

To examine whether work-related stressors before retirement were associated with changes in the sleep characteristics during the transition to retirement, we calculated mean change (for sleep duration) and RRs (for other sleep characteristics) and their 95% CIs for each level of the number of different work-related stressors and the individual work-related stressors. To assess group differences, the models included a "work-related stressor × time (i.e. before or after retirement)" interaction term. These analyses were conducted for all the sleep characteristics while adjusting for all aforementioned confounders. In addition, the individual work-related stressors were also analyzed as continuous variables using the aforementioned interaction term to assess differences in changes in sleep characteristics.

Finally, we conducted two sensitivity analyses; we repeated the analyses on the number of work-related stressors, among some of the groups in which the removal of work stress on the changes in sleep could be thought to be particularly visible. First, we included only those who reported sleeping less than 7 h (per 24 h) before retirement (n = 538), as we have previously observed that short sleepers show the greatest changes in both sleep duration and sleep difficulties following retirement [2, 5]. Second, we included only those participants who were working full-time in the last measurement point before retirement (n = 1,432), as they could be hypothesized to especially benefit from the removal of work stress and the pressure to sleep at fixed times.

The SAS 9.4 Statistical Package was used for the analyses (SAS Institute Inc., Cary, NC).

Results

The characteristics of the study population (n = 2,053) before retirement are shown in Table 1. The average age of the participants was 63.2 (SD: 1.3) years, the majority were women (83%), and they equally represented upper-grade and lower-grade nonmanual and manual workers. The final analytical sample was highly similar to the eligible population (n = 5,076) in regard to the background characteristics as well as sleep characteristics in the last available measurement in which the participants were still working (see Supplementary Table S1).

Figure 1 displays unadjusted estimates of average sleep duration every 3 months around retirement. In the measurement immediately before retirement, the participants reported sleeping on average 7 h and 9 min per 24 h. The overall levels of sleep duration increased statistically significantly by 19 min (95% CI: 17–20 min) from the last measurement before retirement to the first measurement after retirement when adjusted for age and gender (Table 2). The results did not markedly change

Table 1. Characteristics of the study population (n = 2,053) in the last measurement before retirement

Background characteristics[a]	n	
Age, M (SD)	2,053	63.19 (1.34)
Gender	2,053	
Men, n (%)		342 (17)
Women, n (%)		1,711 (83)
Occupational status	2,030	
Upper-grade nonmanual, n (%)		669 (33)
Lower-grade nonmanual, n (%)		611 (30)
Manual, n (%)		750 (37)
Self-rated health	2,050	
Good, n (%)		1,521 (74)
Suboptimal, n (%)		529 (26)
Physical activity, MET hours/week, M (SD)	2,038	23.46 (20.15)
Alcohol use, g/week, M (SD)	2,043	58.74 (96.42)
BMI, M(SD)	2,019	26.76 (4.40)
Sleep characteristics[a]		
Sleep duration, M (SD)	2,036	7 h 9 min (51 min)
Difficulties falling asleep, n (%)	2,007	90 (4)
Difficulties maintaining sleep, n (%)	2,017	496 (25)
Waking up too early in the morning, n (%)	2,006	250 (12)
Nonrestorative sleep, n (%)	2,025	154 (8)
Daytime tiredness, n (%)	2,042	283 (17)
Sleep loss due to worry, n (%)	2,045	303 (15)
Moderators: work-related stressors before retirement, n (%)		
Number of work-related stressors	1,820	
0		809 (44)
1		571 (31)
2 or more		440 (24)
Job strain	1,814	
No		1,459 (80)
Yes		355 (24)
Low work time control	1,555	
No		1,181 (76)
Yes		374 (24)
Effort-reward imbalance	1,762	
No		1,299 (74)
Yes		463 (26)
Organizational injustice	1,820	
No		1,366 (75)
Yes		454 (25)

[a]Characteristics are reported as mean (M) and SD for continuous variables and as frequencies (n) and percentages for categorical variables.

when the analyses were additionally adjusted for occupational status, physical activity, alcohol use, BMI, and self-rated health.

Figure 2 displays unadjusted prevalence estimates for the six sleep outcomes: four types of sleep difficulties, daytime tiredness, and sleep loss due to worry every 3 months around retirement. In the measurement immediately before retirement, 5% of the participants reported difficulties falling asleep, 25% reported difficulties maintaining sleep, 12% reported waking up too early in the morning, 8% reported nonrestorative sleep, 17% reported daytime tiredness, and 15% reported losing sleep due to worrying. Statistically significant decrease following retirement was observed in the prevalence of waking up too early in the morning (RR: 0.78, 95% CI: 0.68–0.89), nonrestorative sleep

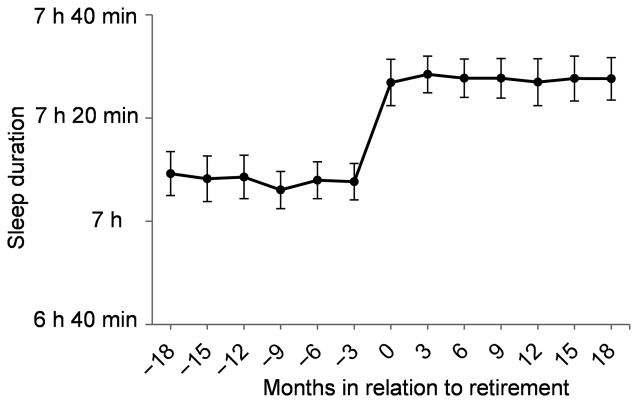

Figure 1. Observed average sleep duration and its 95% confidence intervals per 24 h in relation to retirement. The curve has been smoothed using moving averages.

(RR: 0.69, 95% CI: 0.58–0.83), daytime tiredness (RR: 0.68, 95% CI: 0.62–0.76), and sleep loss due to worry (RR: 0.75, 95% CI: 0.65–0.86) after adjusting for age and gender (Table 2). No statistically significant changes were observed in difficulties falling asleep or in difficulties maintaining sleep. The results did not markedly change when the analyses were fully adjusted.

Results from the analyses examining whether the changes in sleep over the retirement transition are associated with the individual work-related stressors are displayed in Table 3. For each work-related stressor and sleep outcome, the overall picture is of no statistically significant differences in the changes to sleep characteristics during the transition to retirement. There are two exceptions: participants reporting effort–reward imbalance had greater decrease in nonrestorative sleep (RR: 0.50, 95% CI: 0.36–0.69) compared with those who did not report effort–reward imbalance (RR: 0.78, 95% CI: 0.59–1.04; p = 0.03); those reporting job strain before retirement had greater decrease in difficulties maintaining sleep (RR: 0.77, 95% CI: 0.65–0.91) than those without job strain (RR: 0.99, 95% CI: 0.90–1.09; p = 0.01). Similar results were observed when sensitivity analyses of work-related stressors as continuous variables were performed: no statistically significant differences in the sleep changes were observed in any of the work-related stressors.

Table 4 displays results on changes in sleep characteristics across groups exposed to different number of work-related stressors. The only statistically significant difference was observed in changes in difficulties falling asleep; those who were not exposed to any work-related stressor before retirement had a greater decrease in difficulties falling asleep (RR: 0.56, 95% CI: 0.35–0.90) than those exposed to one work-related stressor before retirement (RR: 1.27, 95% CI: 0.87–1.85; p = 0.039). These results did not markedly change when the analyses were additionally adjusted for occupational status, physical activity, alcohol use, BMI, and self-rated health. In further analyses, we combined the two exposure groups ("1" and "2 or more" work-related stressors) resulting in a dichotomized variable indicating whether the participant was exposed to any work-related stressor or not. These analyses replicated the findings of the main analyses.

In the sensitivity analyses including only short sleepers (i.e. those sleeping less than 7/24 h before retirement, n = 538), the results on the changes in sleep across the number of different work-related stressors were similar as in the main analyses (results shown in Supplementary Table S2). In a further analysis,

Table 2. Changes in sleep characteristics during the transition to retirement among the whole study population

	Model 1[a]		Model 2[b]	
Sleep characteristic	Mean change (min)	95% CI	Mean change (min)	95% CI
Sleep duration	19	17–20	19	17–21
	RR	95% CI	RR	95% CI
Difficulties falling asleep	0.90	0.73–1.09	0.85	0.69–1.04
Difficulties maintaining sleep	0.95	0.88–1.02	0.95	0.87–1.02
Waking up too early in the morning	0.78	0.68–0.89	0.76	0.67–0.87
Nonrestorative sleep	0.69	0.58–0.83	0.68	0.56–0.82
Daytime tiredness	0.68	0.62–0.76	0.67	0.60–0.75
Sleep loss due to worry	0.75	0.65–0.86	0.76	0.66–0.87

Changes in sleep duration are reported as mean change (in minutes) and its 95% CI and changes in all the other sleep characteristics as RR and their 95% CIs in the measurement immediately after retirement compared with the measurement immediately before retirement.
[a]Model 1 adjusted for age and gender.
[b]Model 2 additionally adjusted for occupational status, physical activity, alcohol use, BMI, and self-rated health before retirement

only participants who were working full-time before retirement were included (n = 1,432); again, the results on the sleep changes across groups exposed to different number of work-related stressors in the main analysis were replicated (Supplementary Table S3).

Discussion

This is among the first longitudinal studies examining the role of removal of work stress in the changes of various sleep characteristics using dense measurement intervals around the transition to retirement. Sleep duration notably increased and the prevalence of waking up too early in the morning, nonrestorative sleep, daytime tiredness, and sleep loss due to worry decreased immediately or shortly after the transition to statutory retirement in our study population of public sector employees. In contrast, difficulties falling asleep and difficulties maintaining sleep remained at the same level before and after retirement. No systematic associations of individual work-related stressors or the number of different work-related stressors with changes in different sleep characteristics were observed. We found very few of the work-related stressors to be associated with changes in sleep characteristics: given the possibility of chance findings due to multiple testing and the lack of any consistent pattern in these associations and that no differences were indicated by the continuous stress variables, the results from this study suggest that improvements in various sleep characteristic occurring shortly after retirement are likely to be mainly driven by factors other than the removal of work-related stressors.

Although reinforcing the findings of increased sleep duration and decreases in waking up too early in the morning, nonrestorative sleep, and daytime tiredness from the previous studies [1–3, 5, 6], the results from this study indicate that the changes in various sleep characteristics begin to occur immediately or shortly after retirement. Indications of these quick changes in the case of sleep duration were already described by an Australian study, which examined time use across retirement transition and observed that 3 months postretirement approximately 30 min more time per day was used for sleeping than before retirement [27]. Furthermore, the estimates of increased sleep duration from the previous studies with longer measurement intervals [1, 2] are very close to the 19-min increase observed in this study with a dense measurement interval around retirement. Thus, sleep duration seems to increase immediately following retirement and to stay at the same level during the following months and years. This might be partly explained by the possibility of there not being a need for "catch-up sleep" after several months or years after retirement; that is, there is no longer a similar need to compensate for possible sleep debt that may have accumulated during the working days with more sleep during the free days.

To the best of our knowledge, no previous study has examined the changes in sleep loss due to worry following retirement. The changes in sleep loss due to worry seem especially relevant to study when examining the role of removal of work stress, as the stress people are exposed to during the work days may potentially generate worry and hyperarousal and in that way disturb sleep. The prevalence estimates of sleep loss due to worry were observed to noticeably decrease shortly following retirement. However, no differences in the changes of sleep loss due to worry were observed depending on the amount of work stress or the individual work-related stressors the participants were exposed to.

No systematic associations across individual work-related stressors and sleep changes were observed, as only high job strain and effort–reward imbalance before retirement were associated with greater decreases only in difficulties maintaining sleep and nonrestorative sleep, respectively, but not with any other sleep changes. As job strain [10, 28–30], work time control [31, 32], effort–reward imbalance [8, 10, 29], and organizational justice [8, 10] have all been associated longitudinally with sleep quality, it is unclear why the relief from job strain and effort–reward imbalance in particular but not from the other stressors would be associated with changes in sleep following retirement. Furthermore, no differences in sleep changes were observed, when these stressors were used as continuous variables, suggesting, thus, a possibility of chance as an explanation for these findings. Further studies are needed to corroborate these findings with other study populations.

Furthermore, as work-related stressors tend to cluster in the same individuals [11], we examined whether the number of work-related stressors the participants were exposed to would have an effect on the changes in sleep following retirement. Improvement in sleep was not systematically

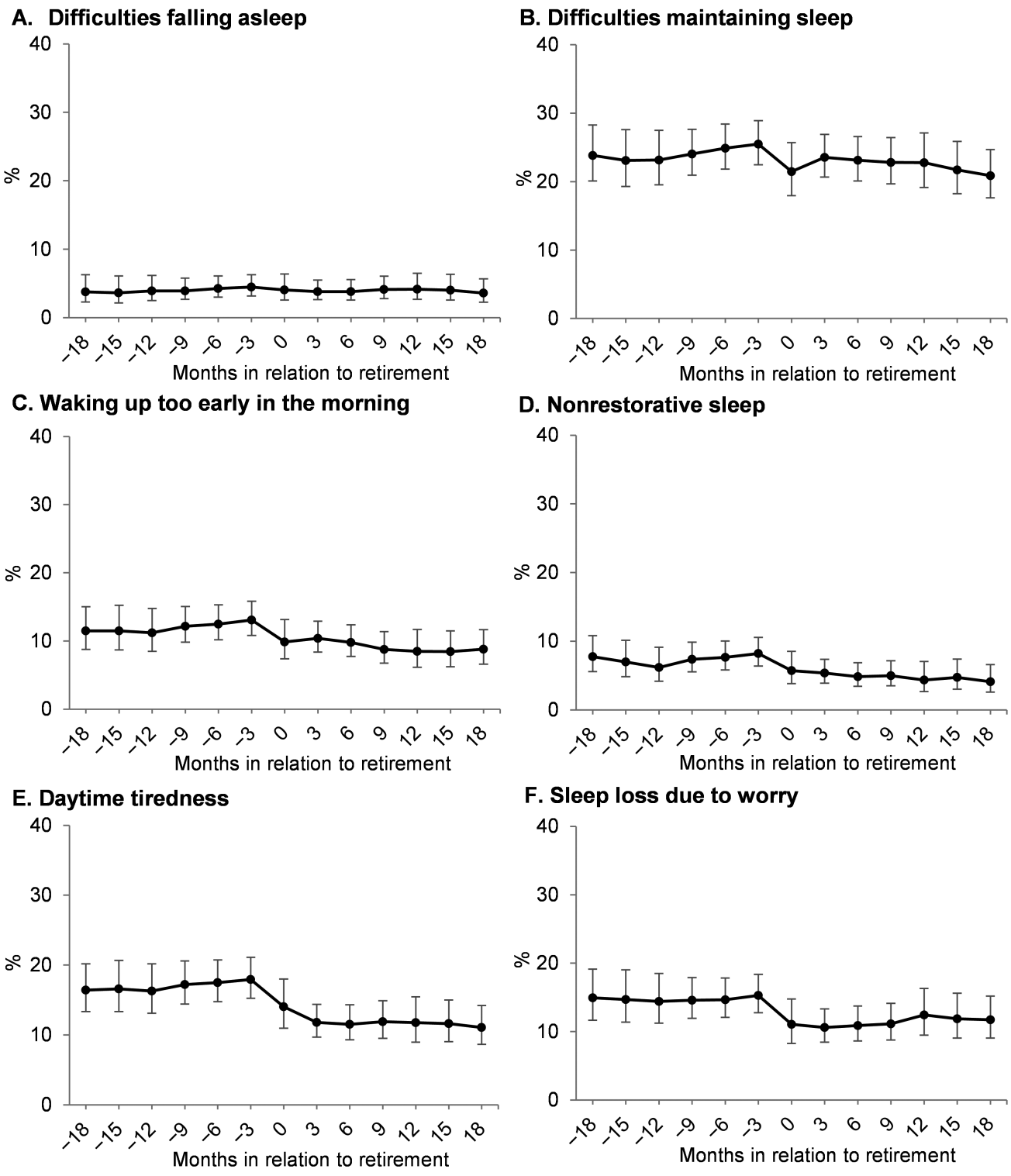

Figure 2. Observed prevalence estimates and their 95% confidence intervals for different sleep characteristics in relation to retirement: (A) difficulties falling asleep; (B) difficulties maintaining sleep; (C) waking up too early in the morning; (D) nonrestorative sleep; (E) daytime tiredness; and (F) sleep loss due to worry. The curves have been smoothed using moving averages.

related to the number of different work-related stressors. Surprisingly, the number of work-related stressors was only associated with changes in difficulties falling asleep; and contrary to the hypothesis, those without work-related stress before retirement had the greatest decrease in difficulties falling asleep. However, this result needs to be interpreted with caution as only 5% of the participants reported difficulties falling asleep before retirement, thus, resulting in very small group sizes when also the number of work-related stressors is considered.

Table 3. Changes in sleep characteristics during the transition to retirement by the work-related stressors of the study population before retirement

	Sleep duration		Difficulties falling asleep		Difficulties maintaining sleep		Waking up too early in the morning		Nonrestorative sleep		Daytime tiredness		Sleep loss due to worry	
Work characteristics	Mean change (min)	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Job strain														
No	18	16–21	0.70	0.51–0.96	0.99	0.90–1.09	0.73	0.61–0.87	0.69	0.54–0.89	0.69	0.60–0.80	0.81	0.68–0.97
Yes	21	16–26	1.11	0.78–1.59	0.77	0.65–0.91	0.87	0.68–1.12	0.52	0.36–0.75	0.63	0.50–0.80	0.68	0.52–0.89
p Value[a]	0.40		0.06		**0.01**		0.26		0.19		0.53		0.26	
p Value for continuous variable [b]	0.67		0.38		0.05		0.38		0.09		0.31		0.44	
Low work time control														
No	18	16–21	0.76	0.56–1.04	0.96	0.86–1.06	0.82	0.68–0.98	0.64	0.49–0.85	0.69	0.60–0.80	0.75	0.62–0.90
Yes	20	15–25	0.97	0.61–1.53	0.91	0.77–1.08	0.77	0.57–1.04	0.67	0.45–0.99	0.66	0.49–0.89	0.81	0.60–1.09
p Value[a]	0.58		0.40		0.64		0.75		0.87		0.77		0.67	
p Value for continuous variable [b]	0.68		0.63		0.82		0.45		0.91		0.37		0.31	
Effort–reward imbalance														
No	19	17–22	0.69	0.48–0.98	0.97	0.87–1.08	0.77	0.64–0.94	0.78	0.59–1.04	0.69	0.60–0.81	0.74	0.61–0.89
Yes	17	12–21	1.06	0.77–1.47	0.85	0.74–0.97	0.78	0.63–0.97	0.50	0.36–0.69	0.67	0.54–0.84	0.90	0.71–1.14
p Value[a]	0.27		0.08		0.14		0.96		**0.03**		0.84		0.21	
p Value for continuous variable [b]	0.84		0.09		0.45		0.86		0.11		0.60		0.79	
Organizational injustice														
No	19	17–22	0.79	0.58–1.08	0.92	0.83–1.02	0.77	0.64–0.91	0.64	0.49–0.84	0.72	0.62–0.83	0.82	0.69–0.99
Yes	16	12–21	0.94	0.63–1.38	0.94	0.80–1.10	0.79	0.61–1.03	0.66	0.48–0.91	0.61	0.48–0.78	0.71	0.54–0.93
p Value[a]	0.21		0.51		0.86		0.83		0.88		0.27		0.37	
p Value for continuous variable[b]	0.56		0.51		0.40		0.93		0.46		0.84		0.48	

Changes in sleep duration are reported as mean change (in minutes) and its 95% CIs and changes in all the other sleep characteristics as RRs and their 95% CIs in the measurement immediately after retirement compared with the measurement immediately before retirement. Analyses are adjusted for age, gender, occupational status, physical activity, alcohol use, BMI, and self-rated health. Statistically significant differences in the changes in sleep characteristics by work-related stressors have been bolded.

[a]p value for "work-related stressor × time (i.e. before or after retirement)" interaction term.

[b]p value for "continuous work-related stressor × time (i.e. before or after retirement)" interaction term.

Table 4. Changes in sleep characteristics during the transition to retirement across the number of work-related stressors before retirement

	Sleep duration		Difficulties falling asleep		Difficulties maintaining sleep		Waking up too early in the morning		Nonrestorative sleep		Daytime tiredness		Sleep loss due to worry	
Number of work-related stressors	Mean change (min)	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Model 1[a]														
0	20	17–22	0.56	0.35–0.90	0.92	0.80–1.05	0.73	0.58–0.93	0.78	0.54–1.11	0.71	0.60–0.85	0.80	0.62–1.03
1	17	13–20	1.27	0.87–1.85	1.03	0.89–1.20	0.83	0.61–1.11	0.68	0.46–1.03	0.74	0.60–0.91	0.71	0.56–0.91
2 or more	19	15–24	0.90	0.63–1.28	0.86	0.75–0.99	0.80	0.64–0.99	0.54	0.40–0.74	0.61	0.49–0.76	0.78	0.60–1.01
p Value[c]	0.44		**0.03**		0.22		0.80		0.30		0.41		0.79	
Model 2[b]														
0	20	17–23	0.51	0.31–0.84	0.92	0.80–1.06	0.71	0.56–0.90	0.75	0.52–1.08	0.72	0.60–0.85	0.82	0.63–1.05
1	16	13–20	1.15	0.77–1.72	1.04	0.89–1.21	0.80	0.59–1.09	0.67	0.44–1.02	0.72	0.57–0.90	0.71	0.56–0.91
2 or more	19	14–23	0.90	0.63–1.30	0.85	0.73–0.98	0.80	0.64–1.01	0.53	0.38–0.72	0.60	0.48–0.76	0.80	0.61–1.04
p Value[c]	0.28		**0.04**		0.17		0.72		0.32		0.47		0.71	

Changes in sleep duration are reported as mean change (in minutes) and its 95% CIs and changes in all the other sleep characteristics as RRs and their 95% CIs in the measurement immediately after retirement compared with the measurement immediately before retirement. Statistically significant differences in the changes in sleep characteristics by the number of work-related stressors have been bolded.

[a]Model 1 adjusted for age and gender.

[b]Model 2 additionally adjusted for occupational status, physical activity, alcohol use, BMI, and self-rated health before retirement.

[c]p Value for the "number of work-related stressors × time (i.e. before or after retirement)" interaction term.

From different characteristics of sleep, duration and quality were available to be examined in this study, but after retirement, changes could be hypothesized to occur also in other characteristics of sleep, such as the timing and variability of sleep [33]. The changes in timing of sleep would be particularly relevant to examine in relation to circadian preference, as it could be hypothesized that especially those with an evening preference (i.e. the evening types) could benefit from retirement, as the need to adjust the sleep timings according to working hours is removed. Objective methods, such as actigraphy, could be a feasible method to study the changes in timing of sleep following retirement as well as to assess the circadian preferences of the participants. Furthermore, further research is needed to investigate other potential underlying mechanisms of the sleep changes, that is, whether improvements in sleep following retirement are explained by positive changes in lifestyle or changes in the way individuals rate their sleep.

A major strength of this study was a large sample with repeated measurements of various sleep characteristics before and after retirement. We were able to calculate the distance from each measurement to the exact date of retirement, and thus, to illustrate the changes in sleep with short (3-month) intervals around retirement. We had information of multiple psychosocial work-related stressors before retirement and were able to examine whether the removal of these stressors affects the changes in sleep while controlling for various confounders. In addition, we repeated the analyses in some specified groups in which the role of removal of work stress and the requirement to sleep at fixed times could be thought to be particularly visible, that is, the preretirement short sleepers (sleeping >7/24 h) and those working full-time before retirement but did not observe systematic associations between the level of work stress and sleep changes even in these groups.

The main limitation of this study is the reliance on self-reported data of sleep, as they may be susceptible to reporting bias and inaccuracies and not correspond to objective measurements [34, 35]. In addition, as the questions on work-related stressors were only added to the FIREA study later on, for the majority of the participants (n = 1,526), the information on work-related stressors was obtained from the FPS study. The FIREA and the FPS studies are not parallel, and thus, the last measurement before retirement has not possibly occurred at the same time in the FPS study as in the FIREA study. This may have led to work stress not being measured immediately before retirement, as the average distance from the last measurement before retirement to the retirement date was on average 1 year and 7 months in the FPS study. Furthermore, in some of the subgroup analyses for individual work-related stressors, the group sizes were very small and this may have limited the statistical power. Finally, the generalizability of our findings may be limited, as the data came from a cohort of relatively healthy public sector employees of European origin in a Nordic welfare state with a relatively generous retirement scheme. Further research is needed to examine, preferable with objective measurements, whether similar findings are observed in other labor market sectors, countries and cultures.

Conclusion

Self-reported sleep duration increased, whereas waking up too early in the morning, nonrestorative sleep, daytime tiredness, and sleep loss due to worry decreased immediately or shortly after the transition to statutory retirement. We did not observe systematic associations across individual work-related stressors or the number of different work-related stressors with the changes in sleep characteristics following retirement. Objective measurements of sleep with short measurement intervals around retirement are needed to fully understand how quantity, quality, and timing of sleep change following retirement from work.

Supplementary material

Supplementary material is available at *SLEEP* online.

Funding

This study was financially supported by Yrjö Jahnsson Foundation (to S.M.), University of Turku Graduate School/Doctoral Programme in Clinical Research (to S.M.), the Academy of Finland (grant numbers 286294, 294154, and 319246 to S.S., 311492 to M.K.); the Finnish Ministry of Education and Culture (to S.S.); the Finnish Work Environment Fund (118060 to S.S.) and the Juho Vainio Foundation (to S.S. and S.M.).

Disclosure

None declared.

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