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# Do Sleep Problems Explain the Association Between Work Stress and the Trajectories of Work Ability From Midlife to Pensionable Age?

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**Objective:** This study examined whether mid-life work stress, defined as job strain and effort-reward imbalance (ERI), predicts work ability trajectories observed 12 years preceding the individual pensionable age. In addition, the role of sleep problems as a mediator in these associations was examined. **Methods:** Survey data were collected from 2707 Finnish municipal employees. **Results:** Identified work ability trajectories were “stable excellent,” “stable good,” “moderate,” and “low decreasing.” Baseline job strain and ERI were associated with a greater likelihood of belonging to impaired work ability trajectories when compared with “stable good” trajectory. Baseline sleep problems explained the association of job strain by 38% and of ERI by 54%. **Conclusions:** Mid-life work stress is associated with work ability in the last years preceding pensionable age. Sleep problems might be a potential mediator in these associations.

**Keywords:** work ability, work stress, job strain, effort-reward imbalance, sleep problems, pensionable age, aging employee

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**Contributors:** S.S., M.V., and J.V. conceived and designed the studies and designed the data collection. M.V., S.S., M.K., P.K.C., S.M., and J.P. contributed to the planning, conception, design, and implementation of the study. M.K., J.P., P.K.C., M.V., and S.M. contributed to the finalization and analysis of the data. M.K. drafted the first manuscript, with critical revisions from M.V., S.S., P.K.C., S.M., J.P., P.K., K.H., J.V., and J.E. All authors approved the final version of the manuscript.

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## LEARNING OUTCOMES

Upon completion of this reading activity, participants should be able to:

- Explain how mid-life work stress affects long-term work ability in the end of the working career.
- Appraise the meaning of sleep as a mediator between work stress and work ability.

Work ability refers, for example, to the balance between work demands and individual resources, which can change across the life course. Health and functional capacity form the basis of work ability.<sup>1</sup> Maintenance of good work ability has been associated with later retirement,<sup>2</sup> work motivation, and better self-rated health.<sup>3</sup> Poor work ability, in turn, has been associated with sickness absence,<sup>4</sup> early retirement intention,<sup>5</sup> and disability pension.<sup>6</sup>

One important work-related factor associated with work ability is work stress, which is often described through two theoretical frameworks. The Job strain model defines job strain as a situation in which employees have high demands and little control over their work.<sup>7,8</sup> The effort-reward imbalance (ERI) model assumes that employees expect adequate reward for their efforts and beneficial effects of employment, and the perceived effort-reward balance depends on the fairness of the relationship between the employer and employee.<sup>9</sup>

A systematic review<sup>10</sup> has shown that high physical and psychological work demands, and poor job autonomy are important determinants of work ability. Similar results have been found in other longitudinal studies.<sup>4,11</sup> In addition, ERI has been shown to predict work ability.<sup>12</sup> The previous longitudinal studies have had short follow-ups, and they have concentrated on employees of all ages,<sup>4,12</sup> not particularly to the last years of the working career where changes in work ability often occur. The only exception is a Finnish 28-year follow-up study, which examined the association between job strain and the development of work ability among initially 44–58 years employees.<sup>11</sup> However, the follow-up ended in 2009, thus an updated view on the role of work stress on work ability is warranted.

One important health factor associated with work stress and work ability is sleep problems. Insomnia is the most common sleep problem, and it has become one of the foremost health concerns for workers internationally.<sup>13</sup> In a conceptual framework by Mullins et al,<sup>14</sup> sleepiness may serve as a mediating variable that connects job demands to important organizational outcomes (eg, job performance). Good sleep has been found to predict improved work ability,<sup>15</sup> whereas sleep problems have been found to predict work disability.<sup>16</sup> According to a meta-analysis, work stress has been associated with a greater risk of experiencing insomnia.<sup>13</sup>

Most of the studies concerning the association between work stress and sleep problems and between sleep problems and work ability have focused on employees of all ages,<sup>13,15</sup> not particularly on the

last years of the working career. In the case of longitudinal studies, the follow-up time has rarely exceeded 5 years.<sup>13,15</sup> In addition, to the best of our knowledge, there is no studies about the mediating role of sleep problems in the association between work stress and long-term trajectories of work ability. A Finnish 4-year follow-up study among working-age physicians suggested that sleep problems acted as a mediator between physicians' on-call work and poor work ability,<sup>17</sup> but the study did not consider the role of work stress.

Although it is possible that there is a two-way association between work stress and work ability, we specifically wanted to study the association from work stress to work ability. In addition, there is strong evidence that psychosocial factors affect work ability.<sup>18</sup> To fill the gaps in previous literature, we aimed to identify long-term trajectories of work ability from midlife to pensionable age and to examine work stress (job strain and ERI) at baseline as a predictor for those trajectories. In addition, sleep problems were examined as a potential mediator between work stress and the work ability trajectories.

## METHODS

### Study Population and Design

This study is based on the Finnish Retirement and Aging Study (FIREA), which is an ongoing longitudinal cohort study of older adults in Finland established in 2013. The eligible population for the FIREA study cohort included all public sector employees whose individual pensionable age was set between 2014 and 2019 and who were working either one of the 27 municipalities in Southwest Finland or in one of the selected nine cities or five hospital districts around Finland in 2012.<sup>19</sup> In this study, the estimated individual pensionable age was obtained from the pension insurance institute for the public sector in Finland (Keva).

The eligible study population for the present study included those FIREA cohort members who completed the first questionnaire while they were still working by the end of the December 2019 (n = 6783), had previously participated in another cohort study, Finnish Public Sector Study (FPS), had given their permission to link their data to the FPS Study, and had responded to at least one FPS survey in 2000–2018 (n = 5029). The FPS Study is an ongoing dynamic cohort study with repeated questionnaire follow-ups every 2 years. The FPS was established in 1997–1998, consisting of employees in the municipal services of 11 Finnish towns and 6 hospital districts providing specialized health care.<sup>20</sup>

To enable accurate estimation of work ability over 12 years before pensionable age, we included only those participants who had responded to a question about work ability at least twice before the pensionable age so that the latter answer was given 2 or 4 years before the pensionable age, and the former answer was given 6, 8, 10, or 12 years before the pensionable age (n = 3656).

Information on work ability 2 years before the pensionable age was taken from the FIREA survey in 2013–2018 or, in the case of

missing information, from the FPS survey in 2012–2018. Other information of work ability was taken from the FPS survey in 2004–2016.

Baseline information on work stress (job strain and ERI), sleep problems, and lifestyle factors (body mass index, physical activity, alcohol risk use, and smoking) before the assessment of work ability trajectories was taken from the FPS survey 14 years before the pensionable age or, in the case of missing information, 16 years before the pensionable age, so that the baseline comprised data from 2–4 years before the assessment of work ability trajectories in 2000–2006 (n = 2707). Figure 1 shows how the data were collected during the study.

The FPS and FIREA studies were conducted in line with the Declaration of Helsinki. The FIREA Study was approved by the Ethics Committee of Hospital District of Southwest Finland and the FPS Study by the Ethics Committee of Hospital District of Helsinki and Uusimaa. The participants are volunteers who have given written informed consent to participate in the study. For the analyses, anonymized data were used.

### Study Context: Pensionable Age

In Finland, the Public Sector Pensions Act regulates the pensionable age of the public sector employees. From 2005 to 2016, the individual pensionable age in the public sector was generally 63–68 years. With the pension reform in January 2017, the lower and upper limits of the individual pensionable age slightly rose depending on the year of birth and life expectancy of the age group. The individual pensionable age is flexible, which means that the pension may be taken out within a certain age range and there is also an upper limit for how long a person can continue working.<sup>21</sup>

### Measures

#### Work Ability

Work ability was assessed with a single question derived from the Work Ability Index (WAI) known as the Work Ability score (WAS): “Assume that your work ability as its best has a value of 10 points. What score would you give your current work ability?”<sup>22</sup> Previous studies have shown that this single-item WAS is a reasonable alternative to the seven-item WAI.<sup>23</sup> The designers of WAI have suggested the same categorization for WAS as for WAI, namely, excellent (10 points), good (8–9 points), moderate (6–7 points), and poor (0–5 points).<sup>24</sup>

#### Work Stress

The assessment of work stress consisted of measures of job strain and ERI. Job strain was assessed by the shorter version<sup>25</sup> of the Job Content Questionnaire.<sup>8</sup> Participants responded to nine items concerning job control and five items concerning psychological demands of job by a 5-point Likert scale (1 = totally agree, 5 = totally disagree). Mean values were calculated for each scale. Participants with job strain, that is, having high demands and low control (yes vs no), were identified using

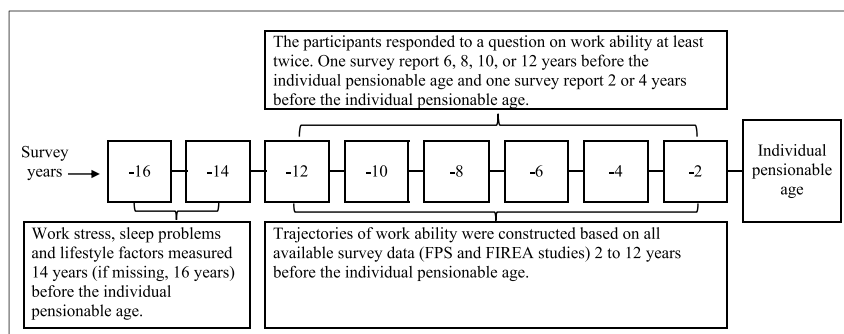


FIGURE 1. Data collection during the study.

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previously defined median-based cutoff points from the FPS Study in 2012,<sup>26</sup> which were 3.33 for job demands and 3.76 for job control.

ERI was assessed by four questions from the 10-item scale by Siegrist.<sup>9,27,28</sup> Participants responded to one question concerning effort and three questions concerning reward by 5-point Likert scale (1 = very little, 5 = very much). ERI was calculated by dividing the effort score by the mean score of reward variables. Participants with ERI (yes vs no) were identified by defining the highest quartile (>1.71) of ERI score as indicating ERI and the remaining three quartiles (≤1.71) not indicating, as previously stated.<sup>26</sup>

**Sleep Problems**

Sleep problems were assessed with the Jenkins Sleep Problems Scale,<sup>29</sup> which includes four items: difficulties falling asleep, difficulties maintaining sleep during the night, waking up too early in the morning, and nonrestorative sleep. Participants were asked to estimate the occurrence of these difficulties over the past 4 weeks (never, 1–3 nights per month, 1 night per week, 2–4 nights per week, 5–6 nights per week, or almost every night). If the frequency of the most frequent symptom participants reported was >4 nights per week, participants were considered to have sleep difficulties (yes vs no), as previously stated.<sup>30</sup>

**Covariates**

Covariates included sociodemographic factors (sex, age, and occupational status) and lifestyle factors (body mass index, physical activity, alcohol risk use, and smoking), which all have shown to associate with work stress or work ability in previous studies.<sup>10,11,15,23,31,32</sup>

All the covariates were defined in the baseline preceding the assessment of work ability trajectories. Demographic factors were defined from the registers and lifestyle factors from the questionnaires.

Information on sex and birth year (transformed to age) was obtained from the pension insurance institute for the public sector in Finland (Keva). The occupational titles were obtained from employers’ records, and they were coded according to the International Standard Classification of Occupations (ISCO) 2001 and categorized into three groups: upper grade nonmanual workers (ISCO classes 1–2, eg, teachers, physicians), lower grade nonmanual workers (ISCO classes 3–4, eg, technicians, registered nurses), and manual workers (ISCO classes 5–9, eg, cleaners, maintenance workers).<sup>33</sup>

Body mass index (kg/m<sup>2</sup>) was calculated based on self-reported body weight and height, and body mass index ≥30 kg/m<sup>2</sup> was defined as obesity (yes vs no).<sup>34</sup> Physical activity was assessed by asking participants to estimate their average weekly hours of leisure-time physical activity (including commuting) within the previous year in walking, brisk walking, jogging, and running, or their equivalent activities. Weekly physical activity was expressed in metabolic equivalent hours, which was dichotomized into two groups (yes vs no), and <14 metabolic equivalent hours/week was defined as low physical activity.<sup>35,36</sup> Alcohol risk use was calculated based on self-reported habitual frequencies of beer, wine, and spirits consumption, and women with >16 drinks/week and men with >24 drinks/week were assessed as having alcohol risk use (yes vs no).<sup>37</sup> Smoking was assessed by asking whether the respondent currently smoked or had ever smoked and dichotomized into current smoker versus nonsmoker (never and ex-smokers).

**Statistical Analyses**

Characteristics of the participants at baseline were calculated as frequencies and proportions for categorical variables and as mean and standard deviation (SD) for age. A comparison between the characteristics of the study population (n = 2707) and the FIREA survey cohort (n = 6783) was carried out for the variables available for every participant. The chi-squared test was used for percentages (sex and occupational status), and the *t*-test was used for means (age and work ability) about 2 years before the pensionable age.

Statistical analysis was conducted in three phases. First, we identified the development of work ability before pensionable age using the latent trajectory analysis. Every participant reported their work ability 2 to 6 times in 12 years preceding pensionable age. Responses were given an average of 3.2 (SD 0.6) times. PROC TRAJ macro in SAS 9.4 (SAS Institute) was used to estimate latent trajectories. The two-step procedure formulated by Nagin and Odgers<sup>38</sup> was used to determine the optimal numbers of latent trajectories and to choose the number and order of regression parameters. In the first step, increasing number of work ability trajectory models (1–8) were fitted with polynomial shape and in the next step we additionally used the quadratic and liner trajectories models to test the models chosen in first step. Assessment of model fit was based on Bayesian information criterion values, Akaike information criterion values, log-likelihood, posterior probabilities, prevalence of latent classes, and odds of correct classification (model-fit statistics for trajectory models [1–8] are presented in Supplemental Digital Content, Table S1, <http://links.lww.com/JOM/B390>). Based on the model fit criteria, we chose a four-class polynomial model as the best-fitted model. It displayed high Bayesian information criterion values and Akaike information criterion values, high log-likelihood, the prevalence of ≥5% for all four latent classes, and odds of correct classification values ≥5 in all trajectories, indicating better reliability for further analyses. Our manuscript largely meets the guidelines for latent trajectory analysis described in the GRoLTS Checklist<sup>39</sup> (Supplemental Digital Content, Table S2, <http://links.lww.com/JOM/B391>).

In the second phase of the statistical analysis, we examined whether job strain and ERI predicted the membership of the different trajectory groups. Multinomial logistic regression analysis was used to calculate odds ratios (ORs) and their 95% confidence intervals (CIs) for job strain and ERI. “Stable good” work ability was used as a reference group, because it was the largest of the groups. The models were initially adjusted for demographic factors (model 1) and additionally adjusted for lifestyle factors (model 2).

In the third phase of the statistical analysis, we examined whether sleep problems mediate the association between work stress and work ability trajectories. Requirements for mediation include that there is a main effect between the exposure and the outcome, and that the mediator is associated with both the exposure and the outcome. A chi-squared test was used to examine the association between baseline work stress and baseline sleep problems (see Supplemental Digital Content, Table S3, <http://links.lww.com/JOM/B392>, which demonstrates the association between work stress and sleep problems). Multinomial logistic regression analysis was used to calculate ORs and their 95% CIs for sleep problems to examine whether baseline sleep problems predict the membership of different trajectory groups (see Supplemental Digital Content, Table S4, <http://links.lww.com/JOM/B393>, which demonstrates the associations of sleep problems with different trajectory groups). To examine mediation, sleep problems were added to model 3 for the association between job strain/ERI and work ability trajectory membership. Percentage of excess risk mediated (PERM) was then calculated. The variables with higher PERM values are regarded as mediators in the concept of traditional difference method, which is based on the Baron’s and Kenny’s method.<sup>40,41</sup> The PERM was calculated using the following formula<sup>2</sup>:

$$PERM = \frac{OR \left( \begin{matrix} \text{demographics and} \\ \text{lifestyle related} \\ \text{factors adjusted} \end{matrix} \right) - OR \left( \begin{matrix} \text{demographics and} \\ \text{lifestyle related factors,} \\ \text{and sleep problems adjusted} \end{matrix} \right)}{OR \left( \begin{matrix} \text{demographics and} \\ \text{lifestyle related} \\ \text{factors adjusted} \end{matrix} \right) - 1} \times 100$$

However, the traditional mediation analysis described above does not assume the interaction between exposure and mediator. This omission has been noted in the new causal inference methods that are based on

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the counterfactual framework. Using the SAS macro, we used the counterfactual mediation analysis that allows the presence of exposure-mediation interaction and decomposes the effects into natural direct and natural indirect effects. In the total effect, both natural direct and indirect effects are considered to estimate the ORs for the association between exposure and outcome. We also calculated the proportion (%) of the total effect the mediator in question explains. We performed a counterfactual mediation analysis, as presented by Valeri and VanderWeele,<sup>42,43</sup> using dichotomous exposures (job strain and ERI), dichotomous mediator (sleep problems), and dichotomous outcome variables (stable excellent, moderate, and low decreasing work ability vs stable good work ability). The outcomes were modeled using logistic regression.

All statistical analyses were performed using SAS statistical software, version 9.4 (SAS Institute).

### RESULTS

The majority of the participants were women (84%), and the mean age at baseline was 49.6 years (SD 1.57). The participants were evenly divided into different occupational groups, so that 35% of the respondents were manual workers, 35% lower-grade nonmanual workers, and 30% upper-grade nonmanual workers. A total of 21%–22% reported job strain or ERI. The most typical (17%) sleep problem among participants was difficulties maintaining sleep during the night. Any kind of sleep problem was reported by 23% of the participants (see Supplemental Digital Content, Table S5, <http://links.lww.com/JOM/B394>, which demonstrates the characteristics of the participants at baseline). Compared with the eligible population approximately 2 years before the pensionable age (n = 6783), the study population (n = 2707) included slightly fewer individuals working in manual occupations (34% vs 40%) than the eligible population. The other comparisons regarding sex, age, and work ability were negligible.

Four different work ability trajectories were identified (Fig. 2). Predicted probabilities of the trajectory group membership ranged from 0.83 to 0.92 (see Supplemental Digital Content, Table S1, <http://links.lww.com/JOM/B390>, which presents the model-fit statistics for trajectory models). The largest trajectory was “stable good” (71%), indicating individuals who consistently defined their work ability as good. The second largest trajectory was “moderate” (19%), which included individuals who mostly defined their work ability as moderate. Finally, both the “stable excellent” trajectory, indicating individuals who consistently defined their work ability as excellent, and the “low decreasing” trajectory, including individuals whose work

ability was low in the beginning of the trajectory and got even lower over time, included 5% of the participants.

Tables 1 and 2 show the associations of job strain and ERI with the membership of different trajectory groups, with “stable good” as the reference group. After adjusting for sociodemographic and lifestyle factors, job strain was associated with lower odds of belonging to “stable excellent” (OR, 0.40; 95% CI, 0.21–0.75) and higher odds of belonging to “moderate” (OR, 1.65; 95% CI, 1.30–2.09) or “low decreasing” (OR, 1.69; 95% CI, 1.12–2.57) trajectory as compared with the “stable good” trajectory. ERI was associated with higher odds of belonging to “moderate” (OR, 1.70; 95% CI, 1.34 to 2.16) or “low decreasing” (OR, 1.92; 95% CI, 1.27 to 2.88) trajectory as compared with the “stable good” trajectory. Regarding ERI, there was no difference between “stable excellent” and “stable good” trajectories.

Sleep problems were more common for those who reported job strain ( $P < 0.0001$ ) or ERI ( $P < 0.0001$ ) than those who did not (see Supplemental Digital Content, Table S3, <http://links.lww.com/JOM/B392>, which demonstrates the association between work stress and sleep problems). Sleep problems were also associated with the trajectory groups. After adjusting for sociodemographic factors, sleep problems were associated with higher odds of belonging to “moderate” (OR, 1.92; 95% CI, 1.54 to 2.40) and “low decreasing” (OR, 2.97; 95% CI, 2.04 to 4.32) trajectory as compared with the “stable good” trajectory (see Supplemental Digital Content, Table S4, <http://links.lww.com/JOM/B393>, which demonstrates the associations of sleep problems with different trajectory groups). There was no difference between “stable excellent” and “stable good” trajectories, thus in these trajectory group comparisons, the requirements of mediation were not fulfilled.

Tables 1 and 2 show the analyses of sleep problems as a mediator between job strain and ERI in the association with work ability trajectories. Considering job strain, the PERM for sleep problems was 12% (“moderate” vs “stable good”) and 22% (“low decreasing” vs “stable good”). Considering ERI, the PERM for sleep problems was 22% (“moderate” vs “stable good”) and 33% (“low decreasing” vs “stable good”) in the association with work ability.

We complemented traditional analyses by counterfactual mediation analysis, which allows the interaction between the exposure (work stress) and mediator (sleep problems), and which decomposes the exposure effect into direct and indirect effects (Tables 1 and 2). The natural direct effect refers to the association between work stress and work ability trajectories in a scenario where sleep problems would be at the same level despite job strain. Those with high job strain were 1.59 times (95% CI, 1.26–2.01) more likely to belong to “moderate”

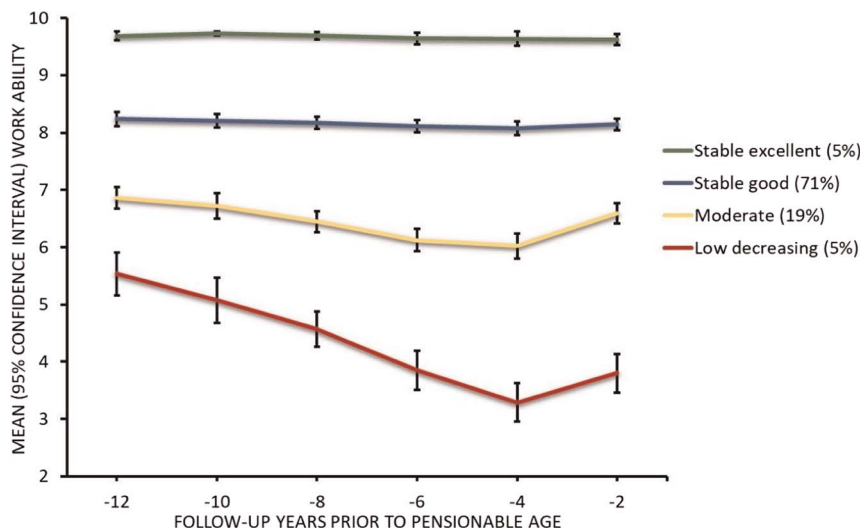


FIGURE 2. Work ability trajectories over 12 years before pensionable age.

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**TABLE 1.** Associations of Job Strain With Different Work Ability Trajectory Groups and the Mediation Effect of Sleep Problems

	Stable Excellent Work Ability <sup>d</sup> vs Stable Good Work Ability <sup>e</sup>			Moderate Work Ability <sup>f</sup> vs Stable Good Work Ability			Low Decreasing Work Ability <sup>g</sup> vs Stable Good Work Ability		
	OR	95% CI	PERM/ Proportion Mediated	OR	95% CI	PERM/ Proportion Mediated	OR	95% CI	PERM/ Proportion Mediated
Model 1 <sup>a</sup>									
Job strain (yes/no)	0.42	0.23 to 0.77		1.65	1.31 to 2.07		1.72	1.15 to 2.58	
Model 2 <sup>b</sup>									
Job strain (yes/no)	0.40	0.21 to 0.75		1.65	1.30 to 2.09		1.69	1.12 to 2.57	
Model 3 <sup>c</sup>									
Job strain (yes/no)	0.41	0.22 to 0.76	2%	1.57	1.24 to 2.20	12%	1.54	1.01 to 2.34	22%
Counterfactual mediation analysis									
Natural direct effect	0.37	0.19 to 0.70		1.59	1.26 to 2.01		1.36	0.90 to 2.07	
Natural indirect effect	0.95	0.86 to 1.05		1.03	0.98 to 1.07		1.17	1.05 to 1.30	
Total effect	0.35	0.19 to 0.66		1.63	1.29 to 2.07		1.59	1.04 to 2.42	
Proportion mediated			3%			7%			38%

<sup>a</sup>Model 1 adjusted for demographic factors (sex, age, and occupational status).

<sup>b</sup>Model 2 additionally adjusted for lifestyle factors (body mass index, physical activity, alcohol risk use, and smoking).

<sup>c</sup>Model 3 additionally adjusted for sleep problems.

<sup>d</sup>Stable excellent n = 149 (5%).

<sup>e</sup>Stable good, n = 1927 (71%).

<sup>f</sup>Moderate, n = 505 (19%).

<sup>g</sup>Low decreasing, n = 126 (5%).

OR, odds ratio; CI, confidence level; PERM, percentage of excess risk mediated.

trajectory instead of “stable good” trajectory. The natural indirect effect, which indicates the excess risk of poorer work ability trajectory that is due to poorer sleep (more problems with sleep), was OR of 1.17 (95% CI, 1.05–1.30) for “low decreasing” trajectory compared with “stable good” trajectory. No excess risk due to poorer sleep was observed when comparing “moderate” and “stable good” trajectories. This indicates that by being associated with having sleep problems, job strain indirectly increases the likelihood belong to “low decreasing” trajectory instead of “stable good” trajectory. The mediator explains

38% of the total effect (“low decreasing” vs “stable good”), which was higher than obtained from the traditional mediation analyses (22%). Thus, the mediating effect of sleep problems analyzed by traditional mediation analyses was confirmed in counterfactual analysis in the comparison between “low decreasing” and “stable good” trajectories.

With regard to ERI, those who had high ERI were 1.49 times (95% CI, 1.17–1.89) more likely to belong to “moderate” trajectory instead of “stable good” trajectory in a scenario where sleep problems would be at the same level regardless of ERI (the natural direct effect). The

**TABLE 2.** Associations of Effort-Reward Imbalance With Different Work Ability Trajectory Groups and the Mediation Effect of Sleep Problems

	Stable Excellent Work Ability <sup>d</sup> vs Stable Good Work Ability <sup>e</sup>			Moderate Work Ability <sup>f</sup> vs Stable Good Work Ability			Low Decreasing Work Ability <sup>g</sup> vs Stable Good Work Ability		
	OR	95% CI	PERM/ Proportion Mediated	OR	95% CI	PERM/ Proportion Mediated	OR	95% CI	PERM/ Proportion Mediated
Model 1 <sup>a</sup>									
Effort-reward imbalance (yes/no)	1.08	0.70 to 1.67		1.82	1.45 to 2.29		1.98	1.33 to 2.96	
Model 2 <sup>b</sup>									
Effort-reward imbalance (yes/no)	1.14	0.74 to 1.76		1.70	1.34 to 2.16		1.92	1.27 to 2.88	
Model 3 <sup>c</sup>									
Effort-reward imbalance (yes/no)	1.21	0.78 to 1.89	NA	1.55	1.21 to 1.97	22%	1.61	1.06 to 2.45	33%
Counterfactual mediation analysis									
Natural direct effect	1.06	0.67 to 1.66		1.49	1.17 to 1.89		1.34	0.88 to 2.03	
Natural indirect effect	0.94	0.83 to 1.06		1.07	0.99 to 1.17		1.30	1.11 to 1.52	
Total effect	0.99	0.64 to 1.53		1.60	1.26 to 2.02		1.73	1.15 to 2.62	
Proportion mediated			NA			18%			54%

<sup>a</sup>Model 1 adjusted for demographic factors (sex, age, and occupational status).

<sup>b</sup>Model 2 additionally adjusted for lifestyle factors (body mass index, physical activity, alcohol risk use, and smoking).

<sup>c</sup>Model 3 additionally adjusted for sleep problems.

<sup>d</sup>Stable excellent, n = 149 (5%).

<sup>e</sup>Stable good, n = 1927 (71%).

<sup>f</sup>Moderate, n = 505 (19%).

<sup>g</sup>Low decreasing, n = 126 (5%).

OR, odds ratio; CI, confidence level; PERM, percentage of excess risk mediated; NA, not available.

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natural indirect effect was OR of 1.30 (95% CI, 1.11–1.52) when comparing “low decreasing” to “stable good” trajectory. No excess risk due to poorer sleep was observed when comparing “moderate” and “stable good” trajectories. This indicates that by being associated with having sleep problems, ERI indirectly increases the likelihood belong to “low decreasing” trajectory instead of “stable good” trajectory. The mediator explains 54% of the total effect (“low decreasing” vs “stable good”), which was higher than that obtained from the traditional mediation analyses (33%). Again, the mediating effect of sleep problems analyzed by traditional mediation analyses was confirmed in counterfactual analyses in the comparison between “low decreasing” and “stable good” trajectories.

## DISCUSSION

The current study is, to best of our knowledge, the first study to examine whether work stress is associated with long-term work ability trajectories from midlife to pensionable age and whether sleep problems mediate their association. We found that, after considering sociodemographic and lifestyle risk factors, job strain and ERI were associated with a greater likelihood of belonging to poorer work ability trajectories, and the association was partly mediated by sleep problems. These findings are consistent with the previous longitudinal studies showing negative associations of job strain<sup>4,10,11</sup> and ERI<sup>12</sup> with work ability, although only one of those studies<sup>11</sup> considered long-term trajectories.

We also examined the extent to which the associations between work stress and work ability were mediated by sleep problems. Sleep problems have been found to be associated with work ability,<sup>15</sup> and in previous meta-analysis, work stress has been found to be associated with insomnia.<sup>13</sup> However, studies examining the mediating role of sleep problems between work stress and work ability are scarce,<sup>17</sup> and to our knowledge, they have not addressed job strain or ERI as sources of stress. In line with the previous evidence, the role of sleep problems as a mediator was supported in our study. Those who had job strain or ERI at baseline experienced more sleep problems at baseline compared with those without job strain or ERI. In addition, those who had sleep problems at baseline belonged more often to “moderate” or “low decreasing” work ability trajectory than the “stable good” trajectory. We measured the mediating effect of sleep problems using the traditional mediation analysis and the counterfactual mediation analysis. The mediating effect of sleep problems was clearly evident when comparing “low decreasing” trajectory with “stable good” trajectory, but less when comparing “moderate” trajectory with “stable good” trajectory. Thus, sleep problems seem to be one potential mechanism explaining the relationship between work stress in mid-life and the declining work ability when approaching the pensionable age.

The specific strength of this study is a considerably large cohort of older public sector employees with repeated work ability measurements over 12 years. The study provided new information on the associations between work stress and long-term work ability described through a data-driven approach, trajectory analysis, as well as with an assessment of the mediating role of sleep problems in this association.

However, the findings of this study have to be considered with the following limitations. The participants were employed in the public sector in Finland, and therefore, the findings may not necessarily be generalizable to other sectors and the general population. In addition, the results should be generalized cautiously to male employees, as 84% of our study population were women. However, a greater proportion (78%) of municipal employees in Finland are women.<sup>44</sup> In addition, the attrition analysis approximately 2 years before the pensionable age showed that there were slightly less individuals working in manual occupations in the study population than in the eligible group. Differences were small, so we assume that they have not had a major impact on the results. Because of the longitudinal study design, health-related selection is a major limitation as the findings were based on only those who had the ability to work until the pensionable age.

Information on work stress and sleep problems was collected before the information on work ability trajectories, but the time order between the exposure (work stress) and the hypothesized mediator (sleep problems) remains open in our study. Therefore, the findings related to the mediating role of sleep should be interpreted cautiously. However, sleep problems have shown great persistence over time,<sup>45</sup> which suggests that their role as a mechanism between work stress and long-term work ability may be substantial. We measured the work stress only at baseline and not during the follow-up. We chose to do this because the aim was to examine the long-term effects of work stress on work ability and avoid the effect of reverse causality. However, it is possible that, for some participants, work stress has changed during the follow-up, for example, due to a job change.

This study was based on self-report measures, which may cause recall bias and common method bias.<sup>46</sup> Because the WAS is only a one question concerning respondent’s own opinion of his/her current work ability compared with the life-time best,<sup>22</sup> it is not known whether the results of work ability in this study are due to a personal response style or external conditions affecting employee’s work ability. However, previous studies have shown that the WAS is a reasonable alternative to the seven-item WAI,<sup>23</sup> which also includes objective questions about work ability, such as diagnosed diseases that describe health.<sup>22</sup> In addition, a person’s subjective experience may have a greater impact on future labor market participation than an objective measure of capacity for work,<sup>1,4</sup> which advocates the use of self-report measures. In the future, however, it would be important to examine the topic of this article with more objective indicators of work stress, work ability, and sleep problems.

Finally, we set the limit of sleep problems according to the limits of the Jenkins Scale<sup>29</sup> (at least one sleep difficulty had occurred more often than 4 nights per week during the past 4 weeks). This was a little higher than the cut-point in the *International Statistical Classification of Diseases and Related Health Problems, 10th Edition*<sup>47</sup> diagnostic criteria where the frequency of sleeping difficulties for the diagnosis is at least three times per week during the past 1 month. In addition to the Jenkins Scale, future studies are warranted to consider alternative ways of measuring sleep and determining the cut-point of sleep problems.

We found that work stress was a significant predictor of impaired work ability toward the end of the working career, although a large part of the association with the poorest work ability trajectory was mediated by sleep problems. Therefore, to prevent impaired work ability potentially leading to premature retirement, it is important for employers, policy makers, and professionals to develop intervention programs that allow both identifying work stress and dealing with it appropriately. Managers should invest in stress-related competence, as they play a key role in the workplaces. In addition, it is important that employees recognize their stress level, know how to manage with stress and associated sleep problems, and, if necessary, seek help for it.

We largely adhered to the STROBE guidelines in writing this article (see Supplemental Digital Content, Table S6, <http://links.lww.com/JOM/B395>).

## CONCLUSIONS

During a 12-year follow-up, job strain and ERI at baseline were associated with decreasing work ability, suggesting that work stress may have role in employees’ work ability several years forward, from midlife to pensionable age. Sleep problems seem to be a potential mediator between work stress and long-term work ability in the last years of the working career.

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