Tuominen, P. P. A. (2023) Exploring the interplay of stress, recovery, and physical activity among teachers, nursing staff, and ICT workers: a comparative study. Journal of Public Health, 2023.

URL: https://doi.org/10.1007/s10389-023-02011-2

Journal of Public Health
https://doi.org/10.1007/s10389-023-02011-2

ORIGINAL ARTICLE

Exploring the interplay of stress, recovery, and physical activity among teachers, nursing staff, and ICT workers: a comparative study

Pipsa P. A. Tuominen[1]

Received: 23 May 2023 / Accepted: 3 July 2023

Abstract

Aim The interaction between stress and recovery in work and leisure time is a complicated combination of occupational demands, personal physical activity (PA), and recovery needs. This study aimed to explore the interaction of stress and recovery with PA and sedentary time among teachers, nursing staff, and information and communication (ICT) workers.
Methods The study included a diverse sample of participants (n = 211) from the occupational groups who participated in the Sustainable Brain Health project in Finland. Statistical analyses involved Fisher–Freeman–Halton's exact test, one-way ANOVA, and Spearman's Rho for analyzing differences between groups and associations between variables.
Results Results indicated that teachers felt more burdened than nursing staff or ICT workers. Teachers also engaged in more measured moderate to vigorous PA (MVPA), although their highest training effect from a single exercise was lower than among other occupations. Measured sedentary time was highest among ICT workers and lowest among nursing staff, despite the latter reporting more sitting during leisure time. Notably, ICT workers reported the highest levels of sitting during working hours. Furthermore, measured stress and relaxation proportions showed a strong negative association, while self-perceived recovery breaks were negatively associated with self-perceived stress. Finally, self-perceived exercise intensity was linked to self-perceived exercise enough for health, and measured MVPA proportion correlated with the training effect.
Conclusion The findings highlight the differential experiences and challenges faced by these occupational groups. The results emphasize the importance of considering gender-dominated occupations when designing interventions to address stress and promote PA.

Keywords Occupation · Burden · Sedentary behavior · Physical activity · Leisure time · Work context

Introduction

The interaction between stress and recovery in work and leisure time is a complicated combination of occupational demands and personal physical activity, and recovery needs. In today's fast-paced and demanding work environments, many individuals experience the burdens of stress and mental fatigue. Prolonged stress is known to cause, worsen, or increase several health-related risks for brain structure, immune system, cardiovascular diseases, and depression (Mariotti 2015). Thus, recovery is needed in every domain of daily life, including occupational and leisure time. For recovery, detachment in the work context (i.e., internal detachment) and outside of work (i.e., external detachment) have been found necessary (Karabinski et al. 2021). Internal detachment may include, for example, breaks during work, and external detachment may include free evenings or weekends, vacations, or sabbaticals.

However, another side of recovery is sedentary behavior (SB), i.e., lying down, reclining position, or sitting, any position or daily tasks where metabolic equivalent (MET) is less than 1.5 (Tremblay et al. 2017). A sedentary lifestyle is also found to be an independent risk factor for cardiovascular diseases, obesity, hypertension, type 2 diabetes, metabolic syndrome, mental health disorders, and depression (Tremblay et al. 2017; Lee et al. 2012; Tremblay et al. 2010). Sedentary time is higher among white-collar (i.e., office) workers than among blue-collar workers (engaged in essentially manual labor), and blue-collar workers have been found to have a higher risk of high perceived stress (Dėdelė et al. 2019).

✉ Pipsa P. A. Tuominen
pipsa.tuominen@tuni.fi

[1] Social Services and Health Care, Physiotherapy degree program, Tampere University of Applied Sciences, Kuntokatu 3, 33520 Tampere, Finland

Published online: 20 July 2023

Further, laborers have been found to have a greater proportion of their work in light PA and MVPA than office workers or healthcare professionals (Prince et al. 2019).

At the same time, insufficient PA is a concern that increases the risks of common chronic diseases (Lee et al. 2012). Working adults spend approximately 60% of their waking time engaged in sedentary behaviors, and only around 4% of the day includes moderate to vigorous physical activity, MVPA (Prince et al. 2019). Adults are recommended at least 150 min/week of moderate or 75 min/week of vigorous aerobic PA, with energy expenditure above 3.0 METs (Tremblay et al. 2017). Furthermore, recommendations encourage avoiding prolonged periods of SBs.

The socioeconomic level has been found to be positively associated with leisure-time physical activity in both genders (Azevedo et al. 2007). Regular PA in leisure time has been found to create a buffer for occupational constraints and demands. When higher occupational stress positively associates with burnout symptoms, higher PA levels seem to negatively associate with occupational stress and burnout (Gerber et al. 2020). Furthermore, a higher amount of standing, moderate and vigorous PA, a higher number of steps, and better cardiovascular fitness have been found to be associated with a higher work ability index value, i.e., better working ability (Husu et al. 2023). Similarly, more time spent lying down and total time in bed have been found to be associated with poorer work ability (Husu et al. 2023).

Occupational PA and the need for recovery have been found to be related among female childcare professionals (Karihtala et al. 2023). Further, a high amount of PA, including moderate, vigorous, and total weekly PA, has been reported to improve workability among teachers (Grabara et al. 2018). In addition, male teachers have had higher moderate to vigorous PA (MVPA) levels than female teachers (Grabara et al. 2018).

Occupational PA levels among nurses consist of light- and moderate-intensity tasks, such as standing or walking and completing direct patient care tasks (Chappel et al. 2017). In addition, healthcare professionals have been found to have higher levels of light PA at work compared to other occupations (Prince et al. 2019). On the other side, shift workers have been found to have similar leisure-time PA levels as day workers but have more sedentary time at work (Hulsegge et al. 2017).

Further, physical detachment at work and leisure activities have been found to be positively associated with a lower need for recovery among office workers (Coffeng et al. 2015). Further, with high job demands, the association between relaxation time and the need for recovery was strong (Coffeng et al. 2015).

Research on gender-dominated differences has discussed that females are more likely to have feelings of stress and burden than their male colleagues (Biswas et al. 2021).

The current study aims to explore the interaction of stress and recovery with work and leisure time. Specifically, we are interested in the differences between three high-stress occupations: teaching, nursing, and information and communication (ICT) work. Education and nursing are known to be female-dominated occupations; thus, we expect these groups to have more perceived and measured stress and less recovery time. We are further interested in differences in sedentary time and physical activity between the mentioned groups. We also expect the male-dominated group to have more moderate to vigorous PA than female-dominated groups.

Finally, we aim to study possible links between self-perceived stress, recovery, and sleep and measured sedentary time and MVPA. We expect self-perceived stress and recovery to be linked with actions in daily life.

Materials and methods

Participants

The participants were teaching professionals working in Tampere in Finland, nursing staff from Eastern Finland, and ICT workers in Oulu, Finland, three target groups of the Sustainable Brain Health project led by Tampere University of Applied Sciences. Occupational groups for the study were selected based on the high cognitive load of their work and knowledge from high-stress occupations. The Sustainable Brain Health project (including the current study) was funded by the Finnish Ministry of Social Affairs and Health from the European Social Fund's Program for Sustainable Growth and Jobs 2014-2020 Finnish structural fund.

Teaching professionals (n = 102) included teachers and principals in primary and high schools. Most of the teachers worked between 8 am and 4 pm at schools. The nursing staff (n = 56) comprised practical and assistant nurses, nurses, and senior nurses from several home care, nursing, and elderly care units. Most nurses were shift workers, but only a few worked overnight. Thus, shift work was not taken into account in the analyses. Finally, ICT workers (n = 53) who participated were network testers, digital, monitoring, and analytics experts, game developers, and consultants from different companies. ICT workers had both office hours and a dual system, where some hours of work were done in the morning or early afternoon and some hours in the late evening due to the international nature of their work.

Questionnaires and Firstbeat® (FB) heart rate (HR), heart rate variability (HRV), and acceleration signal data collection were done between autumn 2020 and autumn 2021. During this period, there were additional safety measures such as wearing masks, separating groups, and encouraging everyone to keep a safe distance due to the Covid-19 situation. Taking the questionnaire and the FB measurements was entirely voluntary. Study information was given to the participants orally and written before data collection. All the participants provided written consent about data collection and use for research purposes. Due to the voluntary participation of healthy adults, ethics committee approval was not needed (TENK 2019).

Measurements and outcomes

Participants completed the baseline questionnaire for the Sustainable Brain Health project. All the participants had an opportunity to participate in a three-day Firstbeat® recording (Firstbeat Technologies Ltd., Jyväskylä, Finland), including two working days and one day off. Simultaneously with the measurement, participants completed the Firstbeat (FB) measurements' initial questionnaire.

On the baseline questionnaire, questions related to stress, recovery, sedentary time, and PA were selected for analysis. Stress was defined as feeling tense, restless, nervous, or anxious, or having sleeping difficulties. Participants were asked to answer a five-point Likert scale (almost always, often, sometimes, seldom, never) about how often they felt stress. Using a 10–point Likert scale (1–10), participants were asked how they recovered from the stress after a day's work. Further, participants were asked separately how many hours they sat during working and leisure time. Other questions were related to participants' perception if they sleep enough, exercise enough for health, and have breaks during the day.

There were similar questions on the FB questionnaire. A five-point Likert scale was used in all claims, including exercising enough for health, exercise intensity for improving fitness, feelings of stress, recovery breaks during the day, and perception of sleeping enough.

The Firstbeat Bodyguard 2-device (Firstbeat Technologies Ltd., Jyväskylä, Finland) was used to measure heart rate (beats per minute), heart rate variability (changes between R-R-intervals in milliseconds, 1000 Hz sampling rate), and tri-dimensional acceleration signals (200 Hz sampling frequency and 8 g (Earth's gravity) measurement range), (Firstbeat analysis server 2021). Two electrodes were attached to the participant's chest at two locations. The measurement was continuous for three days and nights, except during water sports or showering. Furthermore, the recording time (i.e., total time of measurement) was detected. The Firstbeat® analysis program processed the collected raw data, and the amount of sleep, sedentary behaviors (SB, i.e., lying down, reclining position, or sitting), moderate-to-vigorous physical activity (MVPA), and the highest training effect were provided for analysis. SB was calculated from the awake time when the intensity was less than 30% of maximal metabolic equivalent (METmax), MVPA when the intensity was more than 40% of METmax, and the training effect revealed the highest effect of the exercise on a scale of 1.0–5.0 (Firstbeat analysis server 2021; ACSM's Guidelines 2021).

Statistical analysis

Fisher–Freeman–Halton's exact test was used to calculate differences between groups for categorical variables and one-way ANOVA with Welch F-test for continuous variables. Spearman's Rho, r_s, was used to understand the strength of the relationship between variables. Values for ρ were described as having strong or very strong association ($r_s > |0.6|$), moderate association ($|0.4| < r_s < |0.6|$), and weak, very weak, or no association ($r_s < |0.4|$). In all analyses, $p < 0.05$ was considered statistically significant. Analyses were done using IBM SPSS statistical software, version 28.0.1.0.

Results

Characteristics of participants

Altogether 211 individuals participated, and 193 took the Firstbeat® lifestyle assessment. Two participants were excluded with too short measurement time (less than two days) or too high (over 20) detected artifact percentage. Of all participants, 209 were included in the analysis.

Characteristics of groups are presented in Table 1. Occupational groups were teachers (n = 100, 92% female), nursing staff (n = 56, 89% female), and ICT workers (n = 53, 32% female). Fisher–Freeman–Halton's exact test showed a statistically significant difference between groups in gender ($p < 0.001$). Further, the nursing staff had an average lower educational level than teachers and ICT workers ($p < 0.001$). Age was calculated at the year when the participant filled out the questionnaire. One-way ANOVA showed that the nursing staff was on average younger than other groups ($p = 0.009$).

Self-perceived and measured stress, recovery, and sleep

Among teachers, 72.0% of them (n = 100), 58.9% of nursing staff (n = 56), and 52.9% of ICT workers (n = 53) answered that they felt stressed almost always or often. The corresponding answers for seldom or never were 18.0%, 17.9%, and 20.8%, separately. The self-perceived stress differed significantly between the occupational groups ($p = 0.023$).

Among teachers, 58.4% (n = 96) agreed to have at least some recovery breaks during the day. The corresponding answers among nursing staff were 78.8% (n = 52) and 62.5% (n = 40) among ICT workers. Conversely, 29.2% of

Table 1 Characteristics of participants and differences between occupational groups

	Group	N (%) or Mean (SD)	Welch F; df_1, df_2	p
Gender, female % (n = 209)	Teachers (n = 100)	92 (92.0)		<0.001
	Nursing staff (n = 56)	50 (89.3)		
	ICT workers (n = 53)	17 (32.1)		
Age (n = 209)	Teachers	45.3 (9.6)	4.877; 2, 114.5	0.009
	Nursing staff	39.5 (11.4)		
	ICT workers	44.8 (8.2)		
Having children (n = 167)	Teachers (n = 70)	42 (60.0)		0.241
	Nursing staff (n = 51)	23 (45.1)		
	ICT workers (n = 46)	27 (58.7)		
Nursing someone (n = 167)	Teachers (n = 70)	17 (24.3)		0.848
	Nursing staff (n = 51)	11 (21.6)		
	ICT workers (n = 46)	12 (26.1)		
Having a relationship (n = 167)	Teachers (n = 70)	60 (85.7)		0.958
	Nursing staff (n = 51)	42 (82.4)		
	ICT workers (n = 46)	40 (87.0)		
University-level education (n = 197)	Teachers (n = 100)	100 (100.0)		<0.001
	Nursing staff (n = 51)	16 (31.4)		
	ICT workers (n = 46)	38 (82.6)		

teachers, 19.2% of nursing staff, and 27.5% of ICT workers disagreed to having breaks. There were no differences in self-perceived recovery, i.e., the experience that the days include relaxing breaks ($p = 0.187$).

In addition, teachers' (n = 70) feelings about recovery (mean 5.5, SD 2.2 on a 10-point Likert scale) after work were lower than that of nursing staff (n = 51, mean 6.1, SD 2.0) or ICT workers (n = 46, mean 6.2, SD 1.9). However, the difference between groups was not statistically significant (Welsh F = 1.853, $df_1 = 2$, $df_2 = 104.5$, $p = 0.162$).

Altogether, 43.0% of teachers (n = 100) agreed to get enough sleep always or often. The corresponding answers among nursing staff were 41.0% (n = 56) and 54.8% among ICT workers. Here, 49.0% of teachers, 39.3% of nursing staff, and 32.1% of ICT workers answered seldom or never. However, differences in self-perceived sleep were not statistically significant ($p = 0.201$).

Measured stress and relaxation percentages and the proportion of sleep are presented in Table 2. Again, there were no statistically significant differences between occupational groups.

Self-perceived and measured physical activity and sedentary behavior

Self-reported physical activity (amount and intensity), sitting time during working hours and out of work, and measured MVPA and sedentary time are presented in Table 3.

Occupational differences were not found in the self-reported amount and intensity of physical activity. Measured time spent in moderate-to-vigorous PA showed teachers having more MVPA than nursing staff or ICT workers ($p = 0.036$). However, on average, the single exercise's highest intensity (training effect) seemed lower among teachers than

Table 2 Results of measured stress and relaxation percentage and sleep proportion with group means, standard deviations, and Welsh F-test results

	Group	Mean (SD)	Welch F; df_1, df_2	p
Stress percentage (n = 191)	Teachers (n = 96)	55.8 (11.3)	0.641; 2, 94.0	0.529
	Nursing staff (n = 52)	54.3 (11.0)		
	ICT workers (n = 43)	53.5 (13.3)		
Relaxation percentage (n = 191)	Teachers (n = 96)	22.8 (9.3)	1.424; 2, 94.5	0.246
	Nursing staff (n = 52)	24.0 (8.6)		
	ICT workers (n = 43)	26.1 (11.3)		
Sleep proportion (n = 191)	Teachers (n = 96)	32.7 (3.4)	0.784; 2, 88.6	0.460
	Nursing staff (n = 52)	32.3 (4.3)		
	ICT workers (n = 43)	31.8 (4.3)		

Table 3 Results of perceived exercise amount and intensity, measured physical activity proportion and training effect, self-reported sitting, and measured sedentary behavior proportion by Fisher–Freeman–Halton's exact test and with group means, standard deviations, and Welsh F-test results

	Group	N (%) or Mean (SD)	Welch F; df_1, df_2	*p*
Perceived exercising enough for health (n = 188)	Teachers (n = 96)	55 (58.8)		0.436
	Nursing staff (n = 52)	36 (50.0)		
	ICT workers (n = 40)	22 (55.0)		
Perceived exercise intensity is enough to increase fitness (n = 188)	Teachers (n = 96)	46 (47.9)		0.317
	Nursing staff (n = 52)	17 (32.7)		
	ICT workers (n = 40)	18 (35.0)		
Measured MVPA proportion, in % of measurement time (n = 191)	Teachers (n = 96)	2.7 (1.8)	3.447; 2, 101.7	0.036
	Nursing staff (n = 52)	2.0 (1.5)		
	ICT workers (n = 43)	2.3 (1.7)		
Measured training effect, scale 1–5 (n = 191)	Teachers (n = 96)	2.3 (0.9)	2.714; 2, 90.0	0.072
	Nursing staff (n = 52)	2.6 (0.9)		
	ICT workers (n = 43)	3.1 (1.2)		
Self-reported amount of sitting during work, in hours (n = 167)	Teachers (n = 70)	2.8 (1.6)	88.280; 2, 96.9	<0.001
	Nursing staff (n = 51)	2.5 (2.1)		
	ICT workers (n = 46)	6.7 (1.7)		
Self-reported amount of sitting in leisure time, in hours (n = 167)	Teachers (n = 70)	3.1 (1.1)	6.510; 2, 91.2	0.002
	Nursing staff (n = 51)	4.1 (1.8)		
	ICT workers (n = 46)	3.3 (1.4)		
Measured sedentary time proportion, in % of measurement time (n = 191)	Teachers (n = 96)	47.2 (9.5)	9.802; 2, 93.7	<0.001
	Nursing staff (n = 52)	45.7 (12.1)		
	ICT workers (n = 43)	54.3 (9.7)		

nursing staff or ICT workers, even if the difference did not reach statistical significance ($p = 0.072$).

Regarding sedentary habits, teachers and nursing staff had less self-reported sitting than ICT workers during working days ($p < 0.001$). The highest amount of self-reported sitting outside of work was found among nursing staff ($p = 0.002$). However, ICT workers' measured sedentary time proportion was higher than that among teachers and nursing staff ($p < 0.001$).

The Spearman's partial rank correlations for stress, recovery, and sleep

A strong negative association was found between measured relaxation and stress percentages ($r_s = –0.70$, $p < 0.001$; $r_s = –0.68$, $p < 0.001$), with group and group, gender, age, and education controlled, separately. Further, a moderate positive association was found between self-perceived recovery breaks and self-perceived stress ($r_s = 0.49$, $p < 0.001$; $r_s = 0.46$, $p < 0.001$). Further, feelings about self-perceived recovery correlated negatively with self-perceived stress ($r_s = –0.55$, $p < 0.001$; $r_s = –0.54$, $p < 0.001$).

Other relationships between variables were mainly weak or very weak, or there were no associations. Links between variables are presented in Table 4.

The Spearman's partial rank correlations for physical activity and sedentary time

A strong positive association was found between self-perceived exercising enough for health and self-perceived exercise intensity ($r_s = 0.68$, $p < 0.001$; $r_s = 0.67$, $p < 0.001$). In addition, a moderate positive association was found between the training effect and MVPA proportion ($r_s = 0.44$, $p < 0.001$; $r_s = 0.43$, $p < 0.001$).

Other relationships between variables were mainly weak or very weak, or there were no associations. Links between variables are presented in Table 5.

Discussion

The current study focused on stress, recovery, and PA patterns within the context of gender-dominated occupations and aimed to explore the interaction of stress and recovery with work and leisure time PA and sedentary time among teachers, nursing staff, and ICT workers. We expected that participants in female-dominated occupations would have more perceived and measured stress, less recovery, and moderate-to-vigorous PA than male-dominated occupations. We

Table 4 Spearman's partial rank correlations for stress, recovery, and sleep controlled for group and group, gender, age, and education (n = 146)

Controlled for	Self-perceived stress	Measured stress percentages	Self-perceived recovery breaks	Self-perceived feelings about recovery	Measured relaxation percentages	Self-perceived sleep
Measured stress percentages						
group	0.063 (=0.452)					
group, gender, age, and education	0.049 (*p*=0.561)					
Self-perceived recovery breaks						
group	0.485 (*p*<0.001)	0.070 (*p* = 0.401)				
group, gender, age, and education	0.461 (*p*<0.001)	0.065 (*p* = 0.443)				
Self-perceived feelings about recovery						
group	–0.552 (*p*<0.001)	–0.104 (*p*=0.214)	–0.280 (*p*<0.001)			
group, gender, age, and education	–0.544 (*p*<0.001)	–0.102 (*p*=0.228)	–0.250 (*p*=0.003)			
Measured relaxation percentages						
group	–0.147 (*p*=0.079)	–0.695 (*p*<0.001)	–0.076 (*p*=0.364)	0.072 (*p*=0.390)		
group, gender, age, and education	–0.132 (*p*=0.117)	–0.684 (*p*<0.001)	–0.077 (*p*=0.365)	0.072 (*p*=0.395)		
Self-perceived sleep						
group	0.317 (*p*<0.001)	0.137 (*p*=0.099)	0.303 (*p*<0.001)	–0.247 (*p*=0.003)	–0.182 (*p*=0.029)	
group, gender, age, and education	0.373 (*p*<0.001)	0.113 (*p*=0.180)	0.347 (*p*<0.001)	–0.275 (*p*<0.001)	–0.165 (*p*=0.050)	
Measured sleep proportion						
group	0.083 (*p*=0.320)	–0.106 (*p*=0.205)	0.031 *p*=0.712)	–0.070 (*p*=0.405)	0.240 (*p*=0.004)	–0.234 (*p*=0.005)
group, gender, age, and education	–0.007 (*p*=0.935)	–0.152 (*p*=0.072)	–0.026 (*p*=0.763)	–0.034 (*p*=0.686)	0.299 (*p*<0.001)	–0.235 (*p*= 0.005)

also expected self-perceived stress, recovery, and sleep to be linked to sedentary time and PA.

We found that teachers felt more burdened than nursing staff or ICT workers. Furthermore, teachers had more measured MVPA than the other groups, but their highest training effect from a single exercise was lower than that among nursing staff or ICT workers. The measured sedentary time proportion was highest among ICT workers and lowest among nursing staff, even if the latter reported more sitting in their leisure time. However, ICT workers reported the highest levels of sitting during working hours. Furthermore, we found that measured stress and relaxation proportions had a strong negative association, self-perceived recovery breaks had a positive, and feelings about recovery had negative associations with self-perceived stress. In addition, self-perceived exercising enough for health was positively linked to self-perceived exercise intensity. Further, there was a positive link between measured MVPA proportion and the training effect.

Having a closer discussion of the results, we expected female-dominated groups to have more perceived and measured stress and less recovery time. In the current study, teachers felt more burdened than other occupational groups, which might partly reflect their new responsibilities during Covid-19. The role of educators and teachers widened to taking care of children wearing masks, washing hands, keeping the groups small enough and separate, and encouraging everyone to keep a safe distance from each other. Further, during the spring of 2020, schools were closed due to lockdown, and they were waiting to see if new lockdowns would be needed in autumn when measurements were done. This is in line with Kotowski et al. (2022), who found that stress and burnout levels among teachers increased, and they were less able to manage stress than before the Covid-19 situation. They also found that conditions during that time adversely impacted, for example, teaching quality, patience with others, ability to focus, physical and mental health, and ability to separate

Table 5 Spearman's partial rank correlations for physical activity and sedentary behaviors controlled for group and group, gender, age, and education (n = 146)

Controlled for	Self-perceived exercising enough for health	Measured exercise intensity	Measured MVPA proportion	Measured Training Effect	Self-reported amount of sitting during work	Self-reported amount of sitting in leisure time
Self-perceived exercise intensity						
group	0.678 (p<0.001)					
group, gender, age, and education	0.669 (p<0.001)					
Measured MVPA proportion						
group	–0.230 (p=0.005)	–0.207 (p=0.013)				
group, gender, age, and education	–0.288 (p<0.001)	–0.276 (p<0.001)				
Measured training effect						
group	0.006 (p=0.943)	–0.051 (p=0.544)	0.443 (p<0.001)			
group, gender, age, and education	0.000 (p=0.999)	–0.059 (p=0.484)	0.426 (p<0.001)			
Self-reported amount of sitting during work						
group	0.101 (p=0.226)	–0.082 (p=0.326)	0.069 (p=0.411)	0.129 (p=0.122)		
group, gender, age, and education	0.142 (p=0.091)	–0.051 (p=0.550)	–0.023 (p=0.788)	0.069 (p=0.415)		
Self-reported amount of sitting in leisure time						
group	0.143 (p=0.087)	0.047 (p=0.578)	–0.010 (p=0.908)	0.079 (p=0.344)	0.019 (p=0.824)	
group, gender, age, and education	0.124 (p=0.142)	0.006 (p=0.042)	–0.009 (p=0.914)	0.111 (p=0.189)	0.189 (p=0.024)	
Measured sedentary time proportion						
group	–0.149 (p=0.073)	–0.088 (p=0.294)	–0.325 (p<0.001)	–0.008 (p=0.928)	0.017 (p=0.841)	–0.112 (p=0.180)
group, gender, age, and education	–0.092 (p=0.277)	0.012 (p=0.886)	–0.263 (p=0.002)	0.004 (p=0.965)	–0.092 (p=0.277)	–0.026 (p=0.759)

work and family. These things might easily affect the ability to cope at work and the perception of recovery.

In the current study, perceptions of having relaxing breaks during working hours, having recovered enough, or sleeping enough did not differ between occupational groups. Moreover, neither differed measured stress, recovery, or sleep. These results underline that it is possible to have relaxing breaks and recovery time at work and home regardless of occupation. Further, recent studies have shown the importance of physically active breaks for the brain during cognitively demanding tasks (Di Liegro et al. 2019; Scholz et al. 2018; Schmidt-Kassow et al. 2014).

These perceptions and measurements in the current study might also indicate that stress is a highly individual experience. However, the individual experience might not be easily measured and detected. For example, Biswas et al. (2021) reviewed that women were more likely to be exposed to work stress. However, their results were partly contradictory: They also found that men reported higher work stress within the same occupations than women. Also, men often had more physically demanding work than women and were more likely to be exposed to physical hazards, except for women in healthcare occupations (Biswas et al. 2021).

A difference in the proportion of MVPA between occupational groups and a trend toward a difference in training effect was seen in this study. However, no differences were found in self-assessed exercising enough for health or exercise intensity. Teachers had a higher proportion of MVPA than other groups, even if we expected that male-dominated occupations, in this case, ICT workers, would have had the greatest amount of MVPA and the highest training effect. The expectation was based on earlier studies that found that men had more heavy-intensity leisure-time PA than women (Ainsworth et al. 1993), and the males were more active than women (Azevedo et al. 2007). Furthermore, Grabara et al. (2018) found that male teachers had higher MVPA levels than female teachers. In addition, Husu et al. (2016) reported that males had a higher proportion of MVPA than females in all adult age groups, but the difference did not reach statistical significance.

When the teachers engaged in more measured MVPA than the other groups, we suggest this might be their active coping strategy to alleviate stress. Exercise increases blood flow to the brain, improves oxygenation, and increases neurotransmitter levels. In addition, regular physical exercise has been shown to increase the number of capillaries in the brain and the amount of brain-derived nerve growth factor (BDNF), which supports nerve cell function (Syväoja 2016). Most importantly, PA improves cognitive processes and memory, has analgesic and antidepressant effects, and even induces a sense of well-being, strengthening coping with stress (Di Liegro et al. 2019). More active individuals with better cardiovascular fitness might also cope with their routines with less physical effort (Husu et al. 2023).

ICT workers exhibited the highest measured sedentary time proportion and the highest self-reported amount of sitting during working hours, while nursing staff reported more sitting during leisure time. Husu et al. (2023) discussed that longer sedentary time during waking hours was associated with poorer working ability. They wrote that more sedentary individuals might have poorer abilities to respond to the demands of daily life and perceive poorer workability (Husu et al. 2023). Further, Azevedo et al. (2007) found a positive dose-response between age and inactivity among men, meaning that age and male gender increased SB. However, we did not assess workability within the mentioned occupational populations. Our findings highlight the need for tailored interventions to address prolonged sitting and promote active breaks, especially among occupations with high sedentary behavior.

Strength and limitations

The strengths of the current study include the assessment of self-perceived and measured stress, recovery, and PA patterns in daily life, including work and leisure time, rather than snapshot measures in laboratory settings. Also, the populations of occupational groups were large enough for a reliable comparative research design. In addition, the valid and reliable Firstbeat® assessment was carried out for three days, including two days at work and one day off, and the mean values of these three days were used in the analyses.

The limitations of the current study are related to the timeline of the measurements. We do not have comparative data from the time before the Covid-19 pandemic, and all the questionnaires and measurements have been done under various degrees of restrictions. Thus, we cannot estimate how the pandemic has affected work patterns, leisure time PA and SB, or feelings of stress and burden. However, the current results contribute to a better understanding of the complex relationship between work-related stress, recovery, and PA. These can guide future research and workplace interventions to enhance employee well-being and productivity.

Conclusions

The present study investigated the interaction of stress and recovery with work and leisure time physical activity among teachers, nursing staff, and ICT workers. Our findings revealed several important insights into these occupational groups.

First, teachers reported feeling more burdened than nursing staff and ICT workers, indicating the potential impact of occupational demands on perceived stress levels. However, interestingly, teachers engaged in more measured MVPA than the other groups, suggesting their active coping strategy to alleviate stress.

The study shed light on differences in sedentary behavior between the occupational groups. For example, ICT workers exhibited the highest measured sedentary time proportion and the highest self-reported amount of sitting during working hours, while nursing staff reported more sitting during leisure time. These findings highlight the need for tailored interventions to address prolonged sitting and promote active breaks, especially among occupations with high sedentary behavior.

Moreover, our results demonstrated a strong negative association between measured stress and relaxation proportions, suggesting that higher relaxation levels may buffer the effects of stress. Additionally, self-perceived recovery breaks showed a negative association with self-perceived stress, emphasizing the importance of incorporating regular recovery periods for stress reduction.

Notably, the study revealed that self-perceived exercise intensity and self-perceived exercising enough for health were linked, indicating individuals' awareness of the intensity required for health benefits. Furthermore, the measured MVPA proportion correlated positively with the training effect, highlighting the objective physiological impact of PA on individuals' fitness levels.

In conclusion, this study provides valuable insights into the interplay of stress, recovery, and PA among different occupational groups. The findings emphasize the importance of considering gender-dominated occupations when developing targeted interventions for stress reduction and promoting healthy PA behaviors. Future research and workplace interventions can leverage these findings to develop targeted strategies for stress reduction and PA promotion in various occupational settings. These results also contribute to a better understanding of the complex relationship between work-related stress, recovery, and PA and can guide future research and workplace interventions to enhance employee well-being and productivity.

Acknowledgments I am grateful to the project leader Mirva Kolonen and project coordinator Kirsi Toljamo from Tampere University of Applied Sciences, Tampere, Finland, for their great support and efforts in background data collection. I also want to thank the project group for their support; special thanks to Satu Pinola from Oulu University of Applied Sciences, Oulu, Finland, for her help with the questionnaire data curation. Finally, I sincerely thank Ari Mänttäri for his valuable help reviewing the current paper.

Author's contribution Conceptualization, Methodology, Software, Data Curation, Project administration, Resources, Formal Analysis, Investigation, Writing, Review, and Editing.

Funding Open access funding provided by Tampere University including Tampere University Hospital, and Tampere University of Applied Sciences (TUNI). The funding for data was included in the Sustainable Brain Health project (Tampere University of Applied Sciences). There was no separate funding for the research.

Consent for publication and data availability The datasets generated and analyzed during the current study are not publicly available because permission has not been applied for from either the participants or the Sustainable Brain Health project but are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate The study was conducted following the Helsinki Declaration. All the data has been handled under data protection law and good scientific practice throughout the process (Data Protection Act 1050/2018). The participants received written and oral information about the study. In addition, the participants gave written consent for measurements in the Sustainable Brain Health project.

Competing interests The author has no competing interests to declare.

References

ACSM's guidelines for exercise testing and prescription, 11th edition (2021) American College of Sports Medicine. Wolters Kluver

Ainsworth BE, Richardson M, Jacobs DR Jr, Leon AS (1993) Gender differences in physical activity. Women Sport Phys Activ J 2(1):1–16. https://doi.org/10.1123/wspaj.2.1.1

Azevedo MR, Araújo CL, Reichert FF, Siqueira FV, da Silva MC, Hallal PC (2007) Gender differences in leisure-time physical activity. Int J Public Health 52(1):8–15. https://doi.org/10.1007/s00038-006-5062-1

Biswas A, Harbin S, Irvin E, Johnston H, Begum M, Tiong M, Apedaile D, Koehoorn M, Smith P (2021) Sex and gender differences in occupational hazard exposures: a scoping review of the recent literature. Curr Environ Health Reports 8(4):267–280. https://doi.org/10.1007/s40572-021-00330-8

Chappel SE, Verswijveren SJJM, Aisbett B, Considine J, Ridgers ND (2017) Nurses' occupational physical activity levels: a systematic review. Int J Nurs Stud 73:52–62. https://doi.org/10.1016/j.ijnurstu.2017.05.006

Coffeng JK, van Sluijs EM, Hendriksen IJ, van Mechelen W, Boot CR (2015) Physical activity and relaxation during and after work are independently associated with the need for recovery. J Phys Activ Health 12(1):109–115. https://doi.org/10.1123/jpah.2012-0452

Dėdelė A, Miškinytė A, Andrušaitytė S, Bartkutė Ž (2019) Perceived stress among different occupational groups and the interaction with sedentary behaviour. Int J Environ Res Public Health 16:4595. https://doi.org/10.3390/ijerph16234595

Di Liegro CM, Schiera G, Proia P, Di Liegro I (2019) Phys Activ Brain Health Genes 10(9):720. https://doi.org/10.3390/genes10090720

Firstbeat analysis server for research use (2021) Available at: https://support.firstbeat.com/hc/en-us/articles/360038904954-Firstbeat-analysis-server-for-research-use. Accessed 26 June 2023

Gerber M, Schilling R, Colledge F, Ludyga S, Pühse U, Brand S (2020) More than a simple pastime? The potential of physical activity to moderate the relationship between occupational stress and burnout symptoms. Int J Stress Manag 27(1):53–64. https://doi.org/10.1037/str0000129

Grabara M, Nawrocka A, Powerska-Didkowska A (2018) The relationship between physical activity and work ability – a cross-sectional study of teachers. Int J Occup Med Environ Health. https://doi.org/10.13075/ijomeh.1896.01043

Hulsegge G, Gupta N, Holtermann A, Jørgensen MB, Proper KI, van der Beek AJ (2017) Shift workers have similar leisure-time physical activity levels as day workers but are more sedentary at work. Scandinavian J Work Environ Health 43(2):127–135. http://www.jstor.org/stable/26386130

Husu P, Suni J, Vähä-Ypyä H, Sievänen H, Tokola K, Valkeinen H, Mäki-Opas T, Vasankari T (2016) Objectively measured sedentary behavior and physical activity in a sample of Finnish adults: a cross-sectional study. BMC Public Health 16(1):920. https://doi.org/10.1186/s12889-016-3591-y

Husu P, Tokola K, Vähä-Ypyä H, Sievänen H, Vasankari T (2023) Accelerometer-measured physical behavior and cardiorespiratory fitness as indicators of work ability. Int J Environ Res Public Health 20(7):5414. https://doi.org/10.3390/ijerph20075414

Karabinski T, Haun VC, Nübold A, Wendsche J, Wegge J (2021) Interventions for improving psychological detachment from work. J Occupational Health Psychol 26(3):224–242. https://doi.org/10.1037/ocp0000280

Karihtala T, Valtonen AM, Kautiainen H, Hopsu L, Halonen J, Heinonen A, Puttonen S (2023) Relationship between occupational and leisure-time physical activity and the need for recovery after work. Arch Public Health 81(1):17. https://doi.org/10.1186/s13690-022-01017-8

Kotowski SE, Davis KG, Barratt CL (2022) Teachers feeling the burden of COVID-19: impact on well-being, stress, and burnout. Work (Reading, Mass.) 71(2):407–415. https://doi.org/10.3233/WOR-210994

Lee I-M, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, Lancet Physical Activity Series Working Group (2012) Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet 380:219–229

Mariotti A (2015) The effects of chronic stress on health: new insights into the molecular mechanisms of brain-body communication. Future Sci OA 1(3):FSO23. https://doi.org/10.4155/fso.15.21

Prince SA, Elliott CG, Scott K, Visintini S, Reed JL (2019) Device-measured physical activity, sedentary behaviour and cardiometabolic health and fitness across occupational groups: a systematic review and meta-analysis. Int J Behav Nutr Phys Act 16:30. https://doi.org/10.1186/s12966-019-0790-9

Schmidt-Kassow M, Zink N, Mock J, Thiel C, Vogt L, Abel C, Kaiser J (2014) Treadmill walking during vocabulary encoding improves verbal long-term memory. Behav Brain Funct 10:24

Scholz A, Ghadiri A, Singh U, Wendsche J, Peters T, Schneider S (2018) Functional work breaks in a high-demanding work environment: an experimental field study. Ergonomics 61(2):255–264. https://doi.org/10.1080/00140139.2017.1349938

Syväoja S (2016) Liikkuva keho, tehokkaat aivot – liikkumisen merkityksestä oppimiselle. [Moving body, efficient brain - the importance of movement for learning.] Available at https://lihastohtori.wordpress.com/2016/08/17/liikkumisen-merkityksesta-oppimiselle-syvaoja/. Accessed 26 June 2023

TENK (2019) Tutkimuseettinen neuvottelukunta. Ihmiseen kohdistuvan tutkimuksen eettiset periaatteet ja ihmistieteiden eettinen ennakkoarviointi Suomessa. Tutkimuseettisen neuvottelukunnan ohjeita 3/2019. Helsinki, Finland. [Finnish National Board on Research Integrity, TENK. Ethical principles of research involving human subjects and ethical prior checking in human sciences in Finland. Guidelines of the Research Ethics Advisory Board 3/2019. Helsinki, Finland.]

Tremblay MS, Colley RC, Saunders TJ, Healy GN, Owen N (2010) Physiological and health implications of a sedentary lifestyle. Appl Physiol Nutr Metab 35(6):725–740. https://doi.org/10.1139/H10-079

Tremblay MS, Aubert S, Barnes JD, Saunders TJ, Carson V, Latimer-Cheung AE, SFM C, Altenburg TM, Chinapaw MJM, SBRN Terminology Consensus Project Participants (2017) Sedentary Behavior Research Network (SBRN) - Terminology Consensus Project process and outcome. Int J Behavior Nutrition Phys Activ 14(1):75. https://doi.org/10.1186/s12966-017-0525-8