Safety and Health at Work 12 (2021) 311–316

Contents lists available at ScienceDirect

Safety and Health at Work

journal homepage: www.e-shaw.net

Original article

Associations of Abnormal Sleep Duration with Occupational and Leisure-time Physical Activity in the Working Population: A Nation-wide Population-based Study

Myeonghun Beak [1], Won-Jun Choi [2,*], Wanhyung Lee [2], Seunghon Ham [2]

[1] College of Medicine, Gachon University, Incheon, Republic of Korea
[2] Department of Occupational and Environmental Medicine, Gil Medical Center, Gachon University College of Medicine, Incheon, Republic of Korea

ARTICLE INFO

Article history:
Received 12 January 2021
Received in revised form
7 May 2021
Accepted 27 May 2021
Available online 22 June 2021

Keywords:
KNHANES
Leisure-time physical activity
Occupational physical activity
Sleep duration

ABSTRACT

Background: The present study investigated the association between two domains of physical activity (occupational physical activity [OPA] and leisure-time physical activity [LTPA]) and sleep duration.

Methods: We investigated 3,421 paid workers from the Korea National Health and Nutrition Examination Survey, 2014–2015. Sleep duration was categorized into three categories (short for less than 5 h, optimal for 5–9 h, and long for more than 9 h). OPA and LTPA were defined in terms of answers to relevant questions. Odds ratios were calculated for sleep duration according to each physical activity domain using multinomial logistic regression models.

Results: There were 464 subjects (13.6%) who showed short sleep duration, and 169 subjects (4.9%) who showed long sleep duration. Prevalence of OPA and LTPA was higher in male workers than in female workers (for OPA: 3.67% and 1.76%, respectively, $p = 0.0108$; for LTPA: 16.14% and 6.07%, respectively, $p < 0.0001$). The odds ratio of OPA for long sleep duration in female workers was 3.35 (95% confidence interval, 1.37–8.21). Otherwise, LTPA was not associated with sleep duration in female paid workers, nor both physical activity domains in male paid workers.

Conclusion: Female paid workers with work-related physical activity were at risk of oversleeping. These findings also suggested that physical activity has distinct associations with sleep duration according to the physical activity domains and sex.

1. Introduction

The beneficial effects of physical activity (PA) on health are well-known. However, much of the research on the benefits of PA is limited to leisure-time physical activity (LTPA). In recent studies, it is suggested that occupational physical activity (OPA) can be detrimental on health. For example, OPA increased the risk of myocardial infarction [1] and long-term sickness absence [2]. The concept of these opposite health effects of OPA and LTPA is termed “physical activity health paradox” [3]. However, the “physical activity health paradox” is not well-documented on sleep problems.

Existing studies on the relationship between PA and sleep are inconsistent. In a US population-based study, PA was inversely associated with excessive daytime sleepiness, trouble in concentrating when tired, and leg cramps during sleep [4]. Physical inactivity predicted sleep loss in a Japanese population-based study [5]. However, in a recent meta-analysis including randomized controlled trials, PA has only a small benefit on sleep [6]. In addition, the association between PA and sleep duration remains unclear. In a previous study, an inverse association between walking activities and sleep time was reported [7]. In the other study, PA increased with sleep duration in young-aged participants, but PA was either lower in those reporting more than 8 h of sleep or unrelated to sleep duration in middle-aged and older participants [8]. However, the previous studies have focused on a general population and without adequately addressing work-related factors.

Sleep duration is an essential factor on individuals’ health which is not restricted to sleep problems and important for performance at work. Deviation from an optimal sleep duration is not only an indicator of poor sleep but also a maker for overall health. People

* Corresponding author. 38-13, Dokjeom-ro 3beon-gil, Namdong-gu, Incheon, 21565, Republic of Korea.
E-mail address: wjchoi@gachon.ac.kr (W.-J. Choi).

2093-7911/$ – see front matter
https://doi.org/10.1016/j.shaw.2021.05.007

with short or long sleep durations were more likely to report sleep disturbances [9,10]. Furthermore, both short and long sleep durations have been associated with negative impacts on health, including higher risks of cardiovascular diseases, diabetes, obesity, depression, and mortality [11–13]. In addition, sleeping optimal duration is important for productivity and safety in the workplace. The relationship of sleep duration with sickness absence and presenteeism showed a U-shape pattern in US employees, which suggests both short and long sleep durations may be associated with lower productivity at work [14]. Also, sleep duration is better associated with accidents and accident risk than sleep quality in transportation industry [15].

In the present study, we investigated the association of sleep duration with OPA and LTPA in the general working population using data from the Korea National Health and Nutrition Examination Survey (KNHANES). The main purpose of this study was to investigate the association between physical activity and optimal sleep duration. Main hypothesis was that OPA, but not LTPA, would be associated with short and/or long sleep durations.

2. Materials and methods

2.1. Study population

This study was based on data from the KNHANES VI (2014–2015), a nationally representative, population-based cross-sectional survey of the health and nutritional status of Korean residents conducted by the Korea Centers for Disease Control and Prevention. Subjects were chosen from multistage probability sampling units according to age, sex, and geographical area based on national household registries [16].

A total of 14,930 individuals participated in the KNHANES VI (2014–2015). Among them, 3,421 paid workers (1,709 men and 1,712 women) aged between 20 and 65 years with no missing data on the questionnaires about sleep duration, OPA, LTPA, sociodemographic factors (age, sex, education, and household income), health behavior-related variables (smoking, alcohol, and body mass index [BMI]), and work-related factors (working hours and shift work) were included for the present study (Fig. 1).

2.2. Main variables

Sleep duration was assessed by the following question: “How many hours of sleep do you get per day on average?” According to the International Classification of Sleep Disorders, “short” and “long” sleepers were those who slept less than 5 h or more than 9 h, respectively [17]. The answers were reported as numerical values. Sleep duration was classified into three categories: short (<5 h), optimal (5–9 h), and long (>9 h).

Information about OPA was collected by using the following questions: “Does your work include high-intensity PAs that make you extremely short of breath or keep your heartbeat very fast for at least 10 minutes?” and “Does your work include moderate-intensity PAs that make you short of breath or keep your heartbeat fast for at least 10 minutes?” Those who answered “yes” to at least one of the two questions were categorized as subjects who performed OPA, while those who answered “no” to both questions were categorized as subjects who did not perform OPA.

Information about LTPA was collected by using the following questions: “Do you usually do high-intensity exercise or take part in leisure activities that make you extremely short of breath or keep your heartbeat very fast for at least 10 minutes?” and “Do you usually do moderate-intensity exercise or take part in leisure activities that make you short of breath or keep your heartbeat fast for at least 10 minutes?” Those who answered “yes” to at least one of the two questions were categorized as subjects who performed LTPA, while those who answered “no” to both questions were categorized as subjects who did not perform LTPA.

2.3. Covariates

In the present study, various covariates such as age, education level, household income level, smoking, alcohol drinking, BMI, working hours, and shift work were included.

Subjects were categorized into five groups according to age (20–29, 30–39, 40–49, 50–59, and 60–65 years). Education level was categorized as up to elementary school (≤6 years), middle school (7–9 years), high school (10–12 years), or college and above (>12 years). Household income level was categorized into quartiles based on yearly household income. For 2015, the lowest household income level (lowest quartile) was less than 650 USD per month, and the highest household income level (highest quartile) was more than 2,400 USD per month.

Smoking, alcohol consumption, and BMI were included as health behavioral factors. For smoking and alcohol drinking, subjects were categorized into relevant groups according to the operational definition used in the KNHANES [18]. Smokers and nonsmokers were defined as those who had smoked more or less than 100 cigarettes in their lifetime, respectively. Past smokers were defined as those who had quit smoking at least 1 month before the survey. Alcohol consumption was categorized into

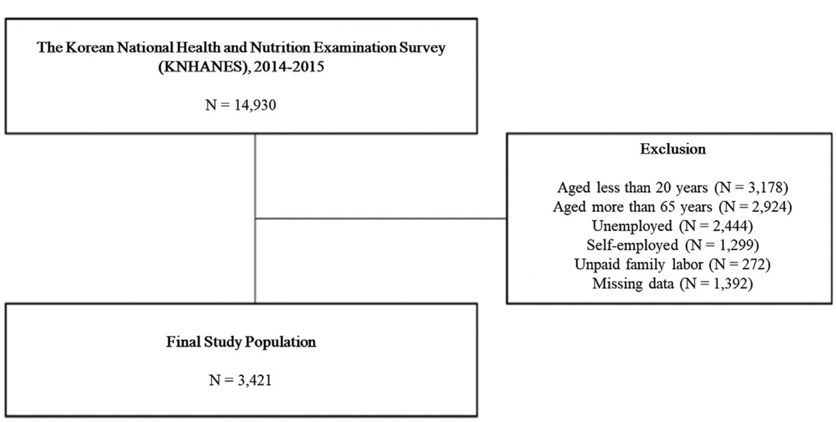

Fig. 1. Schematic diagram of the study population.

Table 1
Baseline characteristics of the study population

Characteristics	Men (n = 1,709)	Women (n = 1,712)	*p* value
	n* (%†)	n* (%†)	
Sleep duration			
Short (<5 h)	224 (13.18)	240 (14.00)	**0.0056**
Optimal	1,423 (82.81)	1,365 (79.28)	
Long (>9 h)	62 (4.01)	107 (6.72)	
Occupational physical activity			
Yes	57 (3.67)	25 (1.76)	**0.0108**
No	1,652 (96.33)	1,687 (98.24)	
Leisure-time physical activity			
Yes	266 (16.14)	104 (6.07)	**<0.0001**
No	1,443 (83.86)	1,608 (93.28)	
Age, y			
20–29	246 (20.05)	321 (24.89)	**0.0003**
30–39	473 (29.76)	390 (23.39)	
40–49	447 (25.93)	462 (26.83)	
50–59	393 (19.23)	400 (19.81)	
60–65	150 (5.03)	139 (5.09)	
Household income			
1st quartile (lowest)	75 (4.22)	125 (7.73)	**0.0009**
2nd quartile	342 (20.65)	372 (20.11)	
3rd quartile	609 (36.23)	590 (34.97)	
4th quartile (highest)	683 (38.90)	625 (37.19)	
Education			
Up to elementary school (≤6 years)	95 (4.53)	155 (6.88)	**<0.0001**
Middle school (7–9 years)	111 (5.63)	173 (8.81)	
High school (10–12 years)	598 (36.70)	638 (38.69)	
College and above (>12 years)	905 (53.14)	746 (45.62)	
Smoking			
Never	453 (28.39)	1,559 (90.40)	**<0.0001**
Past	533 (27.88)	60 (3.61)	
Current	723 (43.73)	93 (5.99)	
Body mass index			
Underweight (<18.5 kg/m^2)	32 (2.36)	110 (7.35)	**<0.0001**
Normal	1,011 (59.16)	1,186 (69.88)	
Obese (≥25.0 kg/m^2)	666 (38.48)	416 (22.77)	
Alcohol drinking			
None	174 (9.50)	409 (21.96)	**<0.0001**
Moderate risk	1,027 (60.68)	1,185 (70.86)	
High risk	508 (29.82)	118 (7.18)	
Working hour			
≤40 h	655 (37.72)	1,081 (63.66)	**0.0001**
>40 h	1,054 (62.28)	631 (36.33)	
Shift work			
Yes	284 (17.67)	283 (16.53)	0.4751
No (fixed daytime workers)	1,425 (82.33)	1,429 (83.47)	

Numbers in bold indicate statistical significance.
* Unweighted sample.
† Weighted sample.

three groups: none, moderate-risk drinking, and high-risk drinking. High-risk drinking was defined according to the amount and frequency of consuming alcoholic beverages: an average of seven glasses or more at a time, twice or more per week for men; and five glasses or more at a time, twice or more per week for women. Based on the World Health Organization guidelines for the Asia-Pacific region [19], BMI was categorized into three groups: <18.5 kg/m^2 for underweight, 18.5–24.9 kg/m^2 for normal, and ≥25.0 kg/m^2 for obese.

Working hours were categorized into two groups based on weekly working hours: less than or equals to 40 h per week and longer than 40 h per week. Based on a previous study [20], daytime workers who answered “work mostly during daytime (between 6 am ~ 6 pm)” were categorized as non-shift workers in the present study. Subjects who answered other than “work during daytime” were categorized as shift workers (e.g., fixed evening work, fixed night work, regular day and night rotating shift, split shift, 24-hour rotating shift, and irregular rotating shift).

2.4. Statistical analysis

KNHANES data were obtained using a complex sampling design. Participants were selected by stratified, clustered, and systematic sampling methods to represent the Korean population. Weighted statistics were calculated using the officially provided factors for strata, clusters, and weights. All statistical analyses were stratified by sex because sex differences in sleep profile are suggested in previous studies. We used Chi-square tests with weighted values to compare differences among baseline characteristics related to sleep duration. Weighted percentages and 95% confidence intervals (CIs) were presented using the sampling clustering weight.

Odds ratios (ORs) and 95% CIs were also calculated using weighted multinomial logistic regression models to estimate the association of sleep duration with OPA and LTPA. The model was adjusted for sociodemographic factors (age, education, and household income), health behavior factors (smoking, alcohol, BMI), and work-related factors (working hours and shift work). All tests were two-sided, and p values of less than 0.05 were considered to have a statistical significance. All analyses were conducted using SAS version 9.3 (SAS Institute, Cary, NC).

3. Results

The baseline characteristics of the study population are presented in Table 1. Among 3,421 study participants, 1,709 (50.0%) were male workers, and 1,712 (50.0%) were female workers. Prevalence of short and long sleep durations in the working population was significantly higher in female workers (14.00% and 6.72%, respectively) than in male workers (13.18% and 4.01%, respectively) ($p = 0.0056$). Participation of OPA was higher in male workers than in female workers (3.67% and 1.76%, respectively, $p = 0.0108$). Participation of LTPA was also higher in male workers than in female workers (16.14% and 6.07%, respectively, $p < 0.0001$).

The weighted prevalence of sleep durations according to subject characteristics is presented in Table 2. OPA was significantly associated with sleep duration in female workers ($p = 0.0016$), not in male workers ($p = 0.4518$). LTPA has no significant association with sleep duration across sex. Age, education, and shift work were associated with sleep duration both in male ($p < 0.0001$, $p = 0.0005$, and $p < 0.0001$, respectively) and female workers ($p < 0.0001$, $p = 0.0011$, and $p = 0.0089$, respectively). Household income and BMI were associated with sleep duration in male workers ($p < 0.0001$ and $p = 0.0401$, respectively), while smoking and working hours, in female workers ($p < .0001$ and $p < .0001$, respectively).

The adjusted ORs for sleep durations in relation to OPA and LTPA are presented in Table 3. OPA was significantly associated with long sleep duration in female workers (OR, 3.833; 95% CI, 1.589–9.243). Despite the lack of statistical significance, LTPA showed lower ORs for both short and long sleep durations in male workers and for long sleep duration in female workers.

4. Discussion

The main purpose of the present study was to determine the association of abnormal sleep duration with OPA and LTPA in working population. Our results showed that OPA was significantly associated with long sleep duration in female workers (OR, 3.833; 95% CI, 1.589–9.243). In contrast, LTPA had no association with any deviation from the optimal sleep duration across sex.

Table 2
Weighted prevalence of sleep duration according to the characteristics of the study population

Characteristics	Sleep duration									
	Men					Women				
	Total	Short (<5 h)	Optimal	Long (>9 h)	*p* value	Total	Short (<5 h)	Optimal	Long (>9 h)	*p* value
	n* (%†)					n* (%†)				
Occupational physical activity										
Yes	57 (100)	7 (17.79)	48 (80.52)	2 (1.69)	0.4518	25 (100)	3 (12.13)	15 (63.83)	7 (24.04)	**0.0016**
No	1,652 (100)	217 (13.01)	1,375 (82.90)	60 (4.10)		1,687 (100)	237 (14.04)	1,350 (79.56)	100 (6.41)	
Leisure-time physical activity										
Yes	266 (100)	30 (10.95)	230 (86.49)	6 (2.55)	0.2835	104 (100)	18 (16.44)	79 (77.45)	7 (6.11)	0.7649
No	1,443 (100)	194 (13.61)	1,193 (82.10)	56 (4.29)		1,608 (100)	222 (13.83)	1,286 (79.41)	100 (6.76)	
Age, y										
20–29	246 (100)	31 (13.02)	189 (75.42)	26 (11.56)	**<0.0001**	321 (100)	23 (8.18)	265 (81.37)	33 (10.44)	**<0.0001**
30–39	473 (100)	64 (13.61)	400 (84.70)	9 (1.70)		390 (100)	45 (13.43)	310 (77.10)	35 (9.47)	
40–49	447 (100)	53 (12.30)	385 (85.23)	9 (2.47)		462 (100)	69 (15.29)	376 (81.09)	17 (3.62)	
50–59	393 (100)	54 (13.26)	325 (84.27)	14 (2.47)		400 (100)	68 (17.03)	318 (79.29)	14 (3.68)	
60–65	150 (100)	22 (15.52)	124 (83.03)	4 (1.45)		139 (100)	35 (26.53)	96 (69.45)	8 (4.03)	
Household income										
1st quartile	75 (100)	17 (19.36)	48 (59.99)	10 (20.65)	**<0.0001**	125 (100)	28 (20.74)	82 (67.35)	15 (11.91)	0.0851
2nd quartile	342 (100)	49 (12.41)	274 (81.54)	19 (6.05)		372 (100)	54 (13.50)	295 (79.98)	23 (6.52)	
3rd quartile	609 (100)	76 (13.51)	514 (83.38)	19 (3.12)		590 (100)	80 (14.11)	471 (79.01)	39 (6.87)	
4th quartile	683 (100)	82 (12.62)	587 (85.43)	14 (1.95)		625 (100)	78 (12.77)	517 (81.63)	30 (5.60)	
Education										
Up to elementary school	95 (100)	14 (15.38)	75 (81.31)	6 (3.31)	**0.0005**	155 (100)	42 (26.15)	106 (70.80)	7 (3.05)	**0.0011**
Middle school	111 (100)	16 (14.45)	85 (76.02)	10 (9.53)		173 (100)	33 (18.68)	131 (74.41)	9 (6.91)	
High school	598 (100)	78 (14.39)	490 (79.43)	30 (6.18)		638 (100)	85 (14.36)	506 (77.89)	47 (7.75)	
College and above	905 (100)	116 (12.02)	773 (85.99)	16 (1.99)		746 (100)	80 (10.96)	622 (82.68)	44 (6.36)	
Smoking										
Never	453 (100)	60 (13.03)	380 (83.86)	13 (3.11)	0.2451	1,559 (100)	210 (13.23)	1,253 (80.08)	96 (6.69)	**<0.0001**
Past	533 (100)	60 (10.32)	456 (85.60)	17 (4.08)		60 (100)	6 (11.70)	50 (81.92)	4 (6.38)	
Current	723 (100)	104 (15.10)	587 (80.35)	32 (4.55)		93 (100)	24 (27.09)	62 (65.58)	7 (7.33)	
Body mass index										
Underweight (<18.5 kg/m^2)	32 (100)	1 (3.39)	28 (87.81)	3 (8.80)	**0.0410**	110 (100)	14 (11.51)	87 (80.35)	9 (8.14)	0.3577
Normal	1,011 (100)	121 (11.60)	854 (84.19)	36 (4.21)		1,186 (100)	157 (13.13)	952 (80.07)	77 (6.81)	
Obese (≥25.0 kg/m^2)	666 (100)	102 (16.21)	541 (80.38)	23 (3.40)		416 (100)	69 (17.49)	326 (76.53)	21 (5.99)	
Alcohol drinking										
None	174 (100)	36 (18.80)	129 (75.79)	9 (5.41)	0.0560	409 (100)	66 (17.42)	317 (74.98)	19 (7.60)	0.0643
Moderate risk	1,027 (100)	119 (11.16)	875 (85,05)	33 (3.80)		1,185 (100)	155 (5.40)	961 (81.24)	87 (5.95)	
High risk	508 (100)	69 (15.51)	419 (80.49)	20 (4.00)		118 (100)	19 (15.37)	69 (5.95)	12 (11.55)	
Working hour										
≤40 h	655 (100)	71 (11.08)	550 (83.89)	34 (5.03)	0.1425	1,081 (100)	134 (12.52)	861 (78.81)	86 (8.67)	**<0.0001**
>40 h	1,054 (100)	153 (14.46)	873 (82.15)	28 (3.39)		631 (100)	106 (16.60)	504 (80.10)	21 (3.30)	
Shift work										
Yes	284 (100)	41 (13.77)	220 (76.68)	23 (9.54)	**<0.0001**	283 (100)	49 (14.81)	204 (73.90)	30 (11.28)	**0.0089**
No	1,425 (100)	183 (13.05)	1,203 (84.12)	39 (2.82)		1,429 (100)	191 (13.84)	1,161 (80.35)	77 (5.81)	

Numbers in bold indicate statistical significance.
* Unweighted sample.
† Weighted sample.

In contrast to OPA, LTPA had no associations with shorter and longer sleep duration. Despite the lack of statistical significance, LTPA showed a possible U-shaped relationship with sleep duration in male workers and lower OR of long sleep duration in female workers. Some randomized controlled trials and open trials suggest PA has some positive effects on sleep duration in general population or population of patients [6]. As this relationship was not statistically significant in working population according to our findings, further study is needed to clarify the relationship between LTPA and sleep duration in working population. Also, the future interventions to improve sleep by means of exercise should focus on the subgroup of workers and individuals' working environments.

Previous studies showed positive associations between exercise levels and sleep duration [21,22]. However, our findings suggest the PA had different associations on sleep according to its domain. Although the underlying mechanisms for this discrepancy remain unclear, there are possible explanations. Work requires being physically active for long periods per day and several consecutive days, with insufficient resting periods. Long periods of PA can cause stress and fatigue [23]. Stress from OPA could induce physiological responses that activate the hypothalamo-pituitary-adrenal axis, central catecholamine systems, and sympatho-adrenomedullary systems, which cause disturbances

Table 3
Odds ratios of two physical activity domains for sleep duration

Domains of physical activity	Short sleep duration (<5 h)		Long sleep duration (>9 h)	
	Adjusted OR	95% CI	Adjusted OR	95% CI
Men				
Occupational physical activity	1.312	0.529–3.253	0.392	0.079–1.950
Leisure-time physical activity	0.783	0.496–1.236	0.596	0.226–1.568
Women				
Occupational physical activity	0.957	0.345–2.657	**3.833**	**1.589–9.243**
Leisure-time physical activity	1.570	0.848–2.904	0.814	0.372–1.783

CI, confidence interval; OR odds ratio. Numbers in bold indicate statistical significance.

in sleep architecture and circadian rhythms [24]. Also, fatigue from OPA can cause deviations from the optimal sleep duration [25]. In contrast, LTPA could alleviate stress and physical fatigue according to previous literatures [26,27].

Another possible explanation is the differences between OPA and LTPA on the effects of cardiovascular system. Considering that work demands to be physically active for long periods without adequate resting times, OPA may cause prolonged elevation of blood pressure and heart rate because of muscle contractions during heavy lifting or static postures in manual work. LTPA also involve heavy lifting but normally in shorter time and under well-controlled conditions [28]. Prolonged elevation of heart rate and blood pressure is a risk factor for poor sleep and mortality [29–31]. Taking these differences into account, the domains of PA should be considered when exploring the complex relationship between PA and sleep in further investigations.

Sex-based differences in the association between work-related PA and sleep duration can be explained by sex differences in physiologic responses to OPA and psychosocial stress. Women have reported higher job burnout and higher scores on exhaustion [32]. Women also more often report health problems related to stress than men [33]. Sex hormones are associated with sex-based differences in stress responses. For example, serotonin and allopregnanolone are neurotransmitters that promote adaptive responses to stress. Estrogen and progesterone regulate serotonin and allopregnanolone levels. Estrogen and progesterone levels decrease during menstruation and after menopause; in turn, serotonin and allopregnanolone synthesis decreases, which weakens stress regulation [34].

This study has several strengths. First, the study was based on a well-established and nationally representative survey, which provides statistical power. To our knowledge, there has not been a study that examined this association in the working population based on a large-scale, nationally representative survey. Second, we included socially homogenous group of workers and addressed work-related factors, which was beneficial considering that the association between sleep duration and PA can differ according to work environments.

There are some limitations to consider in the present study. First, this is a cross-sectional study which is not optimal for investigating causal relationships. A longitudinal study is necessary to examine specific causal relationships. Second, data on PA, sleep duration, and other variables in our study were collected based on self-report questionnaires. Objective measures in PA and sleep are needed in the future study. Third, information on sleep-wake phase and sleep quality was not gathered in KNHANES. Fourth, in addition to OPA and LTPA, PA from household chores may also affect sleep duration. In general, women engage in household chores more than men do in Korea [35]. Future studies are needed to consider the nature and extent of PAs caused by household chores to investigate the relationship between all kinds of PAs and sleep, especially considering gender-specific differences.

In conclusion, different kinds of PAs showed different associations with sleep duration in this study. Considering that the longer sleep duration is a potential risk factor for sleep problems, overall health, safety, and productivity at work, the casual effects of OPA on sleep needs to be assessed in near future, and the awareness on the possible risk of OPA should be raised for workers' health at the perspective of public health.

Conflicts of interest

All authors have no conflicts of interest to declare.

References

[1] Holtermann A, Hansen JV, Burr H, Sogaard K, Sjogaard G. The health paradox of occupational and leisure-time physical activity. Br J Sports Med 2012;46(4): 291–5.
[2] Krause N, Brand RJ, Arah OA, Kauhanen J. Occupational physical activity and 20-year incidence of acute myocardial infarction: results from the Kuopio Ischemic heart disease risk factor study. Scand J Work Environ Health 2015;41(2):124–39.
[3] Holtermann A, Krause N, van der Beek AJ, Straker L. The physical activity paradox: six reasons why occupational physical activity (OPA) does not confer the cardiovascular health benefits that leisure time physical activity does. Br J Sports Med 2018;52(3):149–50.
[4] Loprinzi PD, Cardinal BJ. Association between objectively-measured physical activity and sleep, NHANES 2005–2006. Ment Health Phys Activ 2011;4(2): 65–9.
[5] Ohida T, Kamal AM, Uchiyama M, Kim K, Takemura S, Sone T, Ishii T. The influence of lifestyle and health status factors on sleep loss among the Japanese general population. Sleep 2001;24(3):333–8.
[6] Kredlow MA, Capozzoli MC, Hearon BA, Calkins AW, Otto MW. The effects of physical activity on sleep: a meta-analytic review. J Behav Med 2015;38(3): 427–49.
[7] Basner M, Fomberstein KM, Razavi FM, Banks S, William JH, Rosa RR, Dinges DF. American time use survey: sleep time and its relationship to waking activities. Sleep 2007;30(9):1085–95.
[8] McClain JJ, Lewin DS, Laposky AD, Kahle L, Berrigan D. Associations between physical activity, sedentary time, sleep duration and daytime sleepiness in US adults. Prev Med 2014;66:68–73.
[9] Park S, Cho MJ, Chang SM, Bae JN, Jeon HJ, Cho SJ, Kim BS, Chung IW, Ahn JH, Lee HW, Hong JP. Relationships of sleep duration with sociodemographic and health-related factors, psychiatric disorders and sleep disturbances in a community sample of Korean adults. J Sleep Res 2010;19(4):567–77.
[10] Xiang YT, Ma X, Lu JY, Cai ZJ, Li SR, Xiang YQ, Guo HL, Hou YZ, Li ZB, Li ZJ, Tao YF, Dang WM, Wu XM, Deng J, Lai KY, Ungvari GS. Relationships of sleep duration with sleep disturbances, basic socio-demographic factors, and BMI in Chinese people. Sleep Med 2009;10(10):1085–9.
[11] Tamakoshi A, Ohno Y. Self-reported sleep duration as a predictor of all-cause mortality: results from the JACC study, Japan. Sleep 2004;27(1): 51–4.
[12] Itani O, Jike M, Watanabe N, Kaneita Y. Short sleep duration and health outcomes: a systematic review, meta-analysis, and meta-regression. Sleep Med 2017;32:246–56.
[13] Jike M, Itani O, Watanabe N, Buysse DJ, Kaneita Y. Long sleep duration and health outcomes: a systematic review, meta-analysis and meta-regression. Sleep Med Rev 2018;39:25–36.
[14] Gingerich SB, Seaverson ELD, Anderson DR. Association between sleep and productivity loss among 598 676 employees from multiple industries. Am J Health Promot 2018;32(4):1091–4.
[15] Lemke MK, Apostolopoulos Y, Hege A, Sönmez S, Wideman L. Understanding the role of sleep quality and sleep duration in commercial driving safety. Accid Anal Prev 2016;97:79–86.
[16] Kweon S, Kim Y, Jang MJ, Kim Y, Kim K, Choi S, Chun C, Khang YH, Oh K. Data resource profile: the Korea National Health and Nutrition Examination Survey (KNHANES). Int J Epidemiol 2014;43(1):69–77.
[17] Thorpy MJ. Classification of sleep disorders. Neurotherapeutics 2012;9(4): 687–701.
[18] Ministry of Health and Welfare. Korea Health Statistics 2015: Korea National Health and Nutrition Examination Survey (KNHANES VI-3).
[19] World Health Organization. The Asia-Pacific perspective: redefining obesity and its treatment. Sydney: Health Communications Australia; 2000. Regional Office for the Western Pacific.
[20] Boivin DB, Boudreau P. Impacts of shift work on sleep and circadian rhythms. Pathol Biol (Paris) 2014;62(5):292–301.
[21] King AC, Oman RF, Brassington GS, Bliwise DL, Haskell WL. Moderate-intensity exercise and self-rated quality of sleep in older adults: a randomized controlled trial. JAMA 1997;277(1):32–7.
[22] Youngstedt SD. Effects of exercise on sleep. Clin Sports Med 2005;24(2):355–65.
[23] Ament W, Verkerke GJ. Exercise and fatigue. Sports Med 2009;39(5):389–422.
[24] Reeth O, Weibel L, Spiegel K, Leproult R, Dugovic C, Maccari S. Interactions between stress and sleep: from basic research to clinical situations. Sleep Med Rev 2000;4:201–19.
[25] Goldman SE, Ancoli-Israel S, Boudreau R, Cauley JA, Hall M, Stone KL, Rubin SM, Satterfield S, Simonsick EM, Newman AB, Health. Aging and body composition study. Sleep problems and associated daytime fatigue in community-dwelling older individuals. J Gerontol A Biol Sci Med Sci 2008;63(10):1069–75.
[26] de Vries JD, Claessens BJC, van Hooff MLM, Geurts SAE, van den Bossche SNJ, Kompier MAJ. Disentangling longitudinal relations between physical activity, work-related fatigue, and task demands. Int Arch Occup Environ Health 2016;89(1):89–101.
[27] Craft LL. Exercise and clinical depression: examining two psychological mechanisms. Psychol Sport Exerc 2005;6(2):151–71.

[28] Benetos A, Rudnichi A, Thomas F, Safar M, Guize L. Influence of heart rate on mortality in a French population. Hypertension 1999;33(1):44–52.
[29] Morrell MJ, Finn L, Kim H, Peppard PE, Badr MS, Young T. Sleep fragmentation, awake blood pressure, and sleep-disordered breathing in a population-based study. Am J Respir Crit Care Med 2000;162(6):2091–6.
[30] Nilsson PM, Nilsson JA, Hedblad B, Berglund G. Sleep disturbance in association with elevated pulse rate for prediction of mortality–consequences of mental strain? J Intern Med 2001;250(6):521–9.
[31] Murakami Y, Hozawa A, Okamura T, Ueshima H. Relation of blood pressure and all-cause mortality in 180 000 Japanese participants. Hypertension 2008;51(6):1483–91.
[32] Maslach C, Schaufeli WB, Leiter MP. Job burnout. Annu Rev Psychol 2001;52(1):397–422.
[33] McLean CP, Asnaani A, Litz BT, Hofmann SG. Gender differences in anxiety disorders: prevalence, course of illness, comorbidity and burden of illness. J Psychiatr Res 2011;45(8):1027–35.
[34] Li SH, Graham BM. Why are women so vulnerable to anxiety, trauma-related and stress-related disorders? The potential role of sex hormones. Lancet Psychiatry 2017;4(1):73–82.
[35] KOSIS. Time use survey. Statistics Korea; 2019 [cited May 4, 2021]. Available from: https://kosis.kr/.