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The moderating role of physical activity on the relationship between work intensity and depressive symptoms among the employees

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ABSTRACT

Our aim was to examine the associations between work intensity and depressive symptoms among the working population, as well as to identify the impact of physical activity (PA) on these relationships. Spearman correlation analysis was conducted to analyze the correlations among work intensity, PA, and depressive symptoms. Working hours and working days were positively correlated with depressive symptoms ($r = 0.108$, 0.063; *all* p values were <0.001). Regular PA, exercise time, exercise frequency, and exercise years were negatively correlated with depressive symptoms ($r = -0.121$, -0.124, -0.152, -0.149; all p values were <0.001) and working days ($r = -0.066$, -0.050, -0.069, -0.044; all p values were <0.001), working hours ($r = -0.113$. -0.106, -0.161, -0.123; all p values were <0.001). Working days was positively correlated with working hours ($r = 0.512$, $p < 0.001$). Different levels of PA alleviated the effect of working hours or working days on depressive symptoms. Working hours seemed to be more correlated with depressive symptoms than working days. The results suggest that PA at any level could buffer against the effects of work intensity and might prove a helpful strategy for improving mental health issues among employees.

1. Introduction

Depressive symptoms, one of the most common psychiatric problems, have a prevalence of 37.9% in China and up to 30% in laborers (Huang, Sun, & Zhou, 2020; Qin, Wang, & Hsieh, 2018). Because of the outcomes, including disability, morbidity, mortality, and socioeconomic burden, it has become a significant health problem that urgently needs to be addressed (Roberts, Mountjoy-Venning, Anjomshoa, Banoub, & Yasin, 2019; Wu et al., 2022). People with depressive symptoms have a reduced quality of life and an increased risk of cognitive dysfunction, dementia, coronary heart disease, and stroke compared to the general population (Chan et al., 2019; Tang & Thomas, 2020; Wu et al., 2022). These kinds of mental symptoms can also lead to more serious consequences, such as suicide. A hierarchical cluster analysis from 2015 to 2016 showed that more than half of patients committed suicide within a month of developing a mental disorder, and the reason for this phenomenon was closely related to work patterns with overworking (Nishimura, Yamauchi, Sasaki, Yoshikawa, & Takahashi, 2021). Moreover, employees with depressive symptoms are prone to low energy, sleep disorders, inattention at work and other problems, which can reduce work efficiency and performance (Dewa, Hoch, Nieuwenhuijsen, Parikh, & Sluiter, 2019; Stewart, Ricci, Chee, Hahn, & Morganstein, 2003). They may require long-term treatment, which can increase absenteeism and produce durable impacts on enterprise operations (Gangan & Yang, 2018). More importantly, labor shortages due to depressive symptoms may trigger an upsurge in early retirement, which will hinder the implementation of policies supporting labor force participation in the context of global aging (Konopko et al., 2018).

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Therefore, maintaining the mental health of employees not only ensures the stability of family income but also ensures the first line of defense of enterprise production safety and promotes labor participation in the context of aging.

Current research on depressive symptoms tends to focus on elderly individuals and patients, paying more attention to the interaction between physical diseases and depressive symptoms (MacLean & Wetherall, 2021; Ogunmoroti et al., 2022; Touron et al.). Employees, generally a healthier group, are the core source of family income and the mainstay of social productivity creation and have attracted more attention in terms of physical health problems. Several socioeconomic factors and health behaviors, including economic level, marital status, education level, smoking, alcohol drinking, and lack of exercise, are also likely to be related to depressive symptoms among laborers (Huang et al., 2020; Werneck et al., 2022; G. Y. Zhang, Cai, Zou, Jing, & Wu, 2022). With the increasingly fierce social competition and work pressure, a growing number of studies have focused on the influence of work-related factors on employees' depressive symptoms. For instance, a low psychosocial safety climate, work stress, high work engagement, and long working hours are shown to be associated with an increased risk of depressive symptoms. A 12-month cohort study found that 41–48 and ≥55 h of work per week were positively related to major depressive symptoms (Blackmore et al., 2007; Choi et al., 2021; Zadow, Dollard, Dormann, & Landsbergis, 2021). In addition, the positive association between long working hours and depressive symptoms appears to be stronger in Asia (Virtanen et al., 2018).

Reducing the increasing burden of depressive symptoms should be a priority for future health efforts. Prevention of depressive symptoms was crucial based on the findings of previous studies (Nigatu et al., 2019). However, most of the known risk factors for mental disorders, such as gender, marital status, ethnicity, socioeconomic status, and life events, are unpredictable or difficult to modify (Weich, 1997). Our study emphasizes the moderating role of physical activity (PA) on the relationship between work intensity and depressive symptoms, which provides a new perspective for improving the mental health status of employees. In addition, PA, as a simple and economical intervention, seems to be more operable and universal than intervening in work intensity. Thus, our study has strong practical significance and can provide more effective strategies for preventing the occurrence of employees' depressive symptoms.

1.1. Physical activity

A variety of health surveys have demonstrated that PA not only improves physical fitness and reduces the risk of physical diseases but also helps prevent depressive symptoms. An 11-year cohort study reported that regular leisure-time exercise of any intensity provides protection against future depressive symptoms (Elbe, Lyhne, Madsen, & Krustrup, 2019; Fletcher et al., 2018; Harvey et al., 2018). The findings also suggest that at least 12% of new cases of depressive symptoms could be prevented if adults exercised at least 1 h a week. However, some studies have suggested that any beneficial effects of exercise on reducing the risk of depressive symptoms may be limited to certain subgroups or associated with exercise intensity (Aguilar et al., 2021; Dishman, McDowell, & Herring, 2021). One systematic review including over 3 million adults sampled from 11 nations on five continents found that customary and increasing levels of moderate-to-vigorous PA are inversely associated with incident depression and the onset of subclinical depressive symptoms among adults (Dishman et al., 2021). Beatriz et al. reported that leisure-time PA was the only physical activity domain associated with lower depressive symptoms (Aguilar et al., 2021).

On the other hand, PA can help to cope with work stress and reduce the risk of long-term sickness absence and work-related fatigue among employees (de Vries, van Hoof, Geurts, & Kompier, 2017; Lopez-Bueno, Sundstrup, Vinstrup, Casajus, & Andersen, 2020; X. Yang et al., 2010). Moreover, PA also has the advantages of low cost, high accessibility, and considerable economic and public health benefits (Acs et al., 2016; Bull et al., 2020). Despite the multiple benefits of PA, employees are not motivated enough (Gradidge, Draper, Casteleijn, & Palmeira, 2021). New WHO 2020 guidelines on PA recommended that all adults should undertake 150–300 min of moderate-intensity, 75–150 min of vigorous-intensity PA, or some equivalent combination of moderate-intensity and vigorous-intensity aerobic PA per week (Bull et al., 2020). However, one-third of adults worldwide do not meet the minimum recommended dose of PA (An, 2021). In addition to social environment, economic, and personal factors, work-related factors are barriers associated with PA (Chaabane, Chaabna, Doraiswamy, Mamtani, & Cheema, 2021; Guthold, Stevens, Riley, & Bull, 2018; Motteli & Dohle, 2020; T. Zhang, Ham, & Ren, 2021). As is well known, a person's energy is limited. Overtime reduces employees' leisure time, increases fatigue and work stress, and leads to less energy for PA (Andrade et al., 2019; Wong, Chan, & Ngan, 2019). One study showed that the number of stressors encountered at work, intense physical labor, shift and night work, and job insecurity were negatively associated with leisure-time sports participation (Mutz, Abdel Hadi, & Haeusser, 2020). As the fatigue of manual workers increases, they have less energy to participate in leisure time physical exercise (Blafoss et al., 2019). The benefits of PA for improving mental health are well established and influenced by work-related factors; thus, it is worthwhile to explore how PA may influence depressive symptoms among employees.

1.2. Current research

Overtime work is a risk factor for depressive symptoms; however, little is known about the potential factors moderating this relationship. Previous studies have examined the potential moderating effects of gender, income level, job status, and personality traits on these two relationships (Choi et al., 2021; Parent-Lamarche & Marchand, 2019). To the best of our knowledge, no studies have discussed the effect that PA has on the relationship between working hours and depressive symptoms. To bridge this gap, the purpose of this study was to test the following hypotheses: (1) working hours would be positively related to depressive symptoms, (2) PA levels would be negatively related to depressive symptoms, and (3) PA would moderate the effect of working hours on depressive symptoms such that as levels of PA increase, the relationships between working intensity and depressive symptoms would be weakened.

2. Materials and methods

2.1. Procedures

For this study, cross-sectional data were extracted from the health management center of a third-class hospital in China. Data collection occurred between 2015 and 2020. All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Institutional Review Board (IRB) of Third Xiangya Hospital of Central South University. All participants were notified that the study's purpose was to understand the relationships among PA, work intensity, and depressive symptoms. Participants received a questionnaire containing research content and necessary instructions for filling out questionnaires if they agreed to participate. There was no financial compensation for participants. Finally, 115,917 employees agreed to participate in the survey; however, after excluding missing data, the unemployed, students, and retirees, our sample for analysis comprised 79,984 employees.

2.2. Measures

2.2.1. Demographics

The sociodemographic characteristics examined included the

following: gender, age, ethnicity (Han, Minorities), marriage status (unmarried, married, divorce/widowed, other), regular diet (never, occasionally, always), business socializing (never, sometimes, often, always), drinking status (never, passive drinking, active drinking), and smoking status (never, ever smoking, passive smoking, active smoking).

2.2.2. Depressive symptoms

Depressive symptoms may manifest as negative emotions, sadness, pessimism, indecision, work suppression, insomnia, or fatigue (Xiaolin Yang et al., 2012). We referred to a variety of depressive symptom scales, such as the Patient Health Questionairre-9 (PHQ-9), Self-rating Depression Scale (SDS) and Montgomery Asberg Depression Rating Scale (MADRS), and extracted 6 items that were most associated with depressive symptoms from the "Self-examination questionnaire for health" to evaluate the participants (Ettman et al., 2020; Montgomery & Asberg, 1979; Zung, 1972). The 6 separate items comprised unhappiness, lack of enthusiasm, easily excited and angry, difficulty concentrating, depressed, and hard to relax. Respondents indicated the frequency over the past week that they experienced each statement on a 3-point scale: 1 (not at all), 2 (occasionally), 3 (often), and an example item is 'During the last week, how often did you feel unhappy?' Responses were summed, and scores could range from 6 to 18, with higher scores indicating more depressive symptoms.

Although the 6 items were not mature scales, the results of exploratory factor analysis revealed that they brought about i common factors with a general variance of 64.09%, and the factor loading (β) was between 0.729 and 0.845 (Fig. 1). The Cronbach's α of our scale was 0.887. It showed that the scale had good validity in screening depressive symptoms and could reflect the depressive symptoms of employees to a certain extent.

2.2.3. Work intensity

We considered irregular working hours among participants such as freelancers and the self-employed. We broke down the work intensity from the traditional total number of hours worked per week into two parts, which consisted of the entries 'working days' and 'working hours'. When participants were asked how many days they worked per week, response choices included less than 3 days per week (=1), 3–5 days per week (=2), or more than 5 days per week (=3). When participants were asked the average number of hours worked per day, response choices included less than 4 h per day (=1), 4–6 h per day (=2), 6–8 h per day (=3), and more than 8 h per day (=4).

2.2.4. PA

PA was assessed using a self-report questionnaire associated with a medical examination. The content of the questionnaire mainly focused on the persistence of exercise, which included participation in PA regularly, exercise time, exercise frequency, and exercise years. Whether the participants regularly participated in PA during the past year was determined using a dichotomous inquiry. If the answer was 'yes', specific assessments of exercise adherence were continued. If the answer was 'no' (=0), the evaluation of PA was finished. A further item investigated exercise time; response choices included less than 30 min each time (=1), 30–60 min each time (=2), and more than 60 min each time (=3). Another item investigated exercise frequency; response choices included 1–2 times per week (=1), 3–5 times per week (=2), and more than 5 times per week (=3). The last item investigated exercise years; response choices included less than 1 year (=1), 1–5 years (=2), 6–10

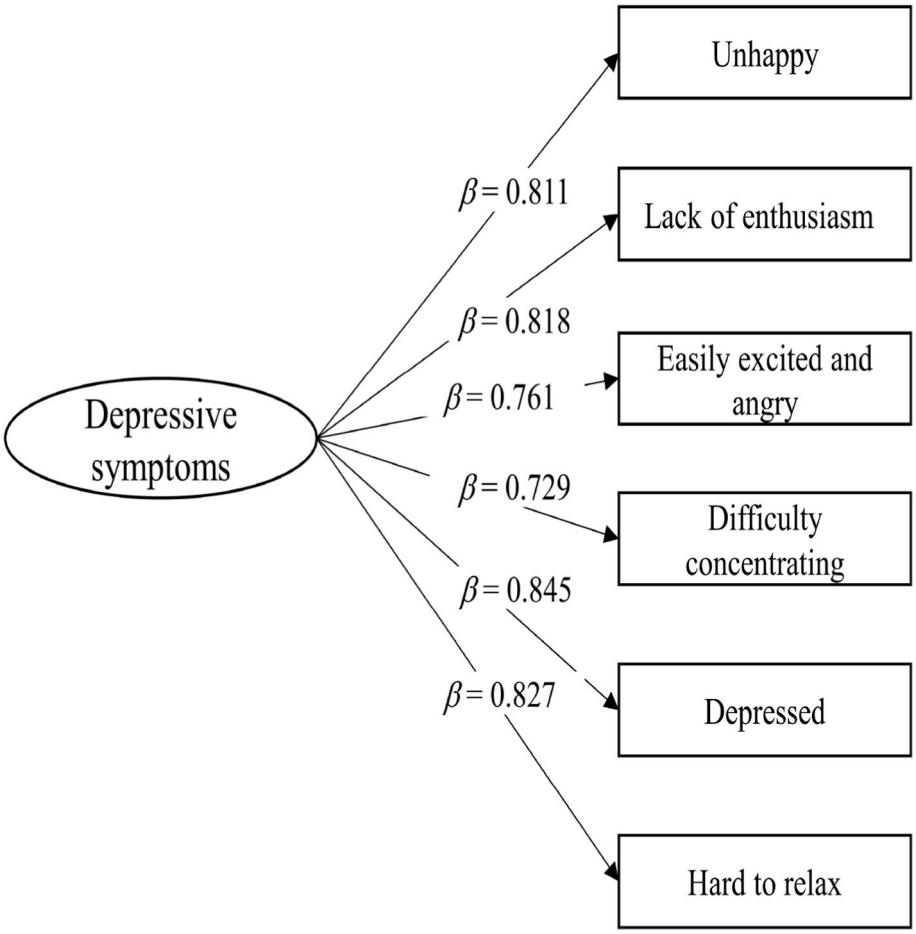

Fig. 1. Standardized factors loading of depressive latent factor items.

years (=3), and more than 10 years (=4).

2.2.5. Statistical analyses

Data were analyzed using SPSS Version 21.0 (IBM Corporation, Armonk, NY, USA) using a significance level of $p < 0.05$.

Age, work intensity (working days and working hours), exercise time, exercise frequency, exercise years, and depressive symptoms were described by the mean ± standard deviation (SD). Gender, ethnicity, marital status, regular diet, business socialization, drinking status, smoking status, and whether they regularly participated in PA were described by number (n) and percentage (%). Exploratory factor analysis was used to explore the degree of fit of the six depressive symptom items in the study. Spearman correlation analysis was conducted to analyze the correlation between work intensity, PA, and depressive symptoms.

Since a combined model would lead to modeling of quadrilateral interactions, the assumptions were modeled separately to increase interpretability. Multiple regression analyses were performed to examine predictors of depressive symptoms, with the independent variables of PA, work intensity, and the interaction of these two variables. First, we examined the effects of work intensity (working days and working hours), participation in PA and their interaction with depressive symptoms. To further examine the moderating effect of the levels of PA on the relationship between work intensity and depressive symptoms, analyses were run containing the independent variables of PA (exercise time, exercise frequency, exercise years), work intensity (working days and working hours), and an interaction term created by multiplying one of the work intensity variables (days worked per week and hours worked per day) by multiplying one of the levels of PA (exercise time, exercise frequency, exercise years). Simple slope analysis was performed to visualize interaction terms and confirm the significance of the moderating effect.

In simple slope analysis, one SD above the mean was regarded ($M + 1$ *SD*) as a high level of work intensity (working days and working hours) and the moderator variables were exercise time, exercise frequency, and exercise years. One *SD* below the mean was a low level of work intensity (M - 1 *SD*). The variables of work intensity (working days and working hours) and the moderator variables (exercise time, exercise frequency, exercise years) were transformed into z scores before regression analysis.

3. Results

3.1. Sociodemographic characteristics

There were 79,984 participants, including 48,199 males (60.3%) and 31,785 females (39.7%), with an average age of 44.95 ± 13.10 years. Sociodemographic characteristics are shown in Table 1.

3.2. Correlation analysis of work intensity, PA, and depressive symptoms

The correlation analysis of work intensity, PA, and depressive symptoms is given in Table 2. The results showed that both working hours and working days were positively correlated with depressive symptoms ($r = 0.108$, 0.063; all p values were <0.001), while regular PA, exercise time, exercise frequency, and exercise years were negatively correlated with depressive symptoms ($r = -0.121$, −0.124, −0.152, −0.149; all p values were <0.001). In addition, a negative association was found between regular PA, exercise time, exercise frequency, exercise years, and working days ($r = -0.066$, −0.050, −0.069, −0.044; all p values were <0.001), as well as working hours ($r = -0.113$. −0.106, −0.161, −0.123; all p values were <0.001). We also found a positive association between working days and working hours ($r = 0.512$, $p < 0.001$).

Table 1
Sociodemographic characteristics (n = 79, 984).

Characteristic		$M \pm SD$ or n (%)
Gender	Male	48, 199 (60.3)
	Female	31, 785 (39.7)
Age, years		44.95 ± 13.10
Ethnicity	Han	77, 177 (96.5)
	Minorities	2807 (3.5)
Marriage status	Unmarried	8965 (11.2)
	Married	68,600 (85.8)
	Divorce/Widowed	2322 (2.9)
	Other	97 (0.1)
Regular diet	Never	25,339 (31.7)
	Occasionally	22,268 (27.8)
	Always	32,377 (40.5)
Business socializing	Never	67,201 (84.0)
	Sometimes	10,772 (13.5)
	Often	1656 (2.1)
	Always	355 (0.4)
Drinking status	Never	52,213 (65.3)
	Passive drinking	1217 (1.5)
	Active drinking	26,554 (33.2)
Smoking status	Never	49,049 (61.3)
	Ever smoking	2734 (3.4)
	Passive smoking	3561 (4.5)
	Active smoking	24,640 (30.8)
Work intensity	Working days	2.36 ± 0.67
	Working hours	2.88 ± 0.95
PA	No	31,921 (39.9)
	Yes	48,063 (60.1)
Exercise time		1.14 ± 1.06
Exercise frequency		1.05 ± 1.03
Exercise years		1.37 ± 1.36
Depressive symptoms		8.40 ± 2.71

Note: $M \pm SD$ = mean ± standard deviation; PA = whether participate in physical activities regularly.

3.3. Moderating effects of PA on work intensity and depressive symptoms

The findings suggested that PA significantly negatively predicts depressive symptoms ($B = -0.501$, $t = -25.910$, $p < 0.001$), while working days ($B = 0.026$, $t = 2.299$, $p = 0.022$) and working hours ($B = 0.122$, $t = 10.201$, p < 0.001) positively predict depressive symptoms (Model 1 in Table 3). The results of the regression analysis incorporating the interaction term showed that the effect of the interaction term of PA with working hours ($B = -0.042$, $t = 2.159$, $p = 0.031$) and working days ($B = -0.038$, $t = 2.019$, $p = 0.044$) on depressive symptoms was significant (Model 2 and Model 3 in Table 3).

Simple slope analysis showed that PA moderated the effect of both work hours and working days on depressive symptoms. Working hours significantly predicted depressive symptoms with or without PA, but the positive effect of working hours on depressive symptoms was reduced among participants who participated in PA compared to those who did not (Fig. 2A) ($B = 0.105$ vs. 0.147; all p values were <0.001). The positive effect of working days on depressive symptoms was observed only in those who did not participate in PA ($B = 0.049$, $t = 3.052$, $p < 0.01$) but not in those who did ($B = 0.010$, $t = 0.759$, $p = 0.448$) (Fig. 2B).

3.4. Moderating effects of exercise time on work intensity and depressive symptoms

The model examining the effect of exercise time and work intensity on depressive symptoms was significant (Model 1 in Table 4). Exercise time was significantly related to depressive symptoms ($B = -0.252$, $t = -26.514$, $p < 0.001$); as exercise time increased, depressive symptoms decreased. Similar to the previous results, both working days and working hours were positively correlated with depressive symptoms ($B = 0.030$, 0.122; $t = 2.685$, 10.206; all p values were <0.01).

Similar to the previous regression analysis, there were significant

Table 2
Correlation analysis of work intensity, PA and depressive symptoms (n = 79,984).

Variables	*M*±*SD*	1	2	3	4	5	6	7
1. Working days	2.36 ± 0.67	1						
2. Working hours	2.88 ± 0.95	0.554***	1					
3. PA	0.60 ± 0.49	−0.066***	−0.113***	1				
4. Exercise time	1.14 ± 1.06	−0.050***	−0.106***	0.876***	1			
5. Exercise frequency	1.05 ± 1.03	−0.069***	−0.161***	0.831***	0.830***	1		
6. Exercise years	1.37 ± 1.36	−0.044***	−0.123***	0.815***	0.794***	0.777***	1	
7. Depressive symptoms	8.40 ± 2.71	0.063***	0.108***	−0.121***	−0.124***	−0.152***	−0.149***	1

Note: M±*SD* = mean ± standard deviation; 1 = Working days; 2 = Working hours; 3 = PA; 4 = Exercise time; 5 = Exercise frequency; 6 = Exercise years; 7 = Depressive symptoms; ***P < 0.001.

Table 3
Regression analysis for the effects of work intensity (working days and working hours), PA and their interaction on depressive symptoms.

Variables	Model 1			Model 2			Model 3		
	B	t	P	B	t	P	B	t	P
Female (Ref: Male)	0.681	27.953	<0.001	0.680	27.901	<0.001	0.681	27.946	<0.001
Age, years	−0.029	−30.257	<0.001	−0.029	−30.323	<0.001	−0.029	−30.291	<0.001
Minorities (Ref: Han)	0.360	7.115	<0.001	0.360	7.117	<0.001	0.360	7.117	<0.001
Marriage status (Ref: Unmarried)									
Married	−0.224	−6.705	<0.001	−0.223	−6.683	<0.001	−0.224	−6.703	<0.001
Divorce/Widowed	0.209	3.247	<0.001	0.211	3.227	0.001	0.211	3.274	0.001
Other	0.030	0.110	0.913	0.030	0.112	0.911	0.029	0.109	0.913
Regular diet	−0.030	−2.762	0.006	−0.031	−2.769	0.006	−0.031	−2.770	0.006
Business socializing	0.372	17.823	<0.001	0.373	17.831	<0.001	0.323	17.830	<0.001
Drinking status (Ref: Never)									
Ever drinking	0.634	8.174	<0.001	0.633	8.169	<0.001	0.634	8.179	<0.001
Drinking	0.139	5.931	<0.001	0.139	5.951	<0.001	0.139	5.944	<0.001
Smoking status (Ref: Never)									
Ever smoking	0.459	8.530	<0.001	0.460	8.543	<0.001	0.460	8.551	<0.001
Passive smoking	0.520	11.152	<0.001	0.521	11.170	<0.001	0.520	11.160	<0.001
Active smoking	0.063	2.474	0.013	0.064	2.503	0.012	0.063	2.492	0.013
Working days	**0.026**	**2.299**	**0.022**	**0.025**	**2.270**	**0.023**	**0.049**	**3.052**	**0.002**
Working hours	**0.122**	**10.201**	**<0.001**	**0.147**	**8.794**	**<0.001**	**0.122**	**10.202**	**<0.001**
PA (Ref: No PA)	**−0.501**	**−25.910**	**<0.001**	**−0.499**	**−25.764**	**<0.001**	**−0.500**	**−25.840**	**<0.001**
Working hours × PA	-	-	-	**−0.042**	**2.159**	**0.031**	-	-	-
Working days × PA	-	-	-	-	-	-	**−0.038**	**2.019**	**0.044**
R^2	**0.061**			**0.061**			**0.061**		
F	324.327			305.556			305.520		

Note: B means unstandardized regression coefficient; Working days and working hours were incorporated into the regression model after being standardized.

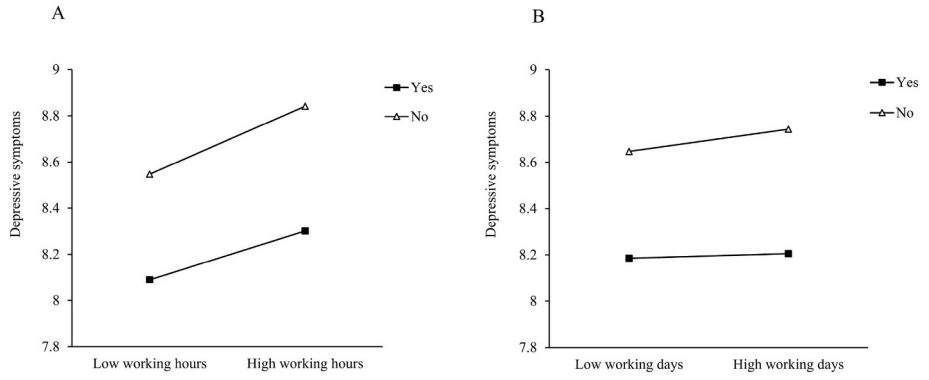

Fig. 2. The Moderating effect of PA (Yes/No) on the relationship between working hours (A) and working days (B), and depressive symptoms.

interaction effects between exercise time and work intensity (working hours and working days) on depressive symptoms (Model 2 and Model 3 in Table 4). Exercise time alleviated the effect of working hours and working days on depressive symptoms ($B = -0.024, -0.022$; $t = -2.586, -2.330$; p values were all <0.05).

Simple slopes analysis, as shown in Fig. 3A, revealed that the predicted slope of working hours on depressive symptoms was statistically significant in both the low and high exercise time groups ($B = 0.146, 0.098$; $t = 9.596, 6.548$; p values were all <0.001). Compared with low exercise time, high exercise time mitigates the effect of high working hours on depressive symptoms. In Fig. 3B, when at the level of low exercise time, high working days were associated with higher depressive symptoms ($B = 0.052$, $t = 3.555$, $p < 0.001$); however, there was no significant effect at the level of high exercise time ($B = 0.008$, $t = 0.568$, $p = 0.570$).

Table 4
Regression analysis for the effects of work intensity (working days and working hours), exercise time and their interaction on depressive symptoms.

Variables	Model 1			Model 2			Model 3		
	B	t	P	B	t	P	B	t	P
Working days	0.030	2.685	0.007	0.029	2.627	0.009	0.030	2.677	0.007
Working hours	0.122	10.206	<0.001	0.122	10.248	<0.001	0.122	10.204	<0.001
Exercise time	−0.252	−26.514	<0.001	−0.251	−26.467	<0.001	−0.251	−26.414	<0.001
Working hours × Exercise time	–	–	–	−0.024	−2.586	0.010	–	–	–
Working days × Exercise time	–	–	–	–	–	–	−0.022	−2.330	0.020
R^2	0.061			0.061			0.061		
F	326.439			307.652			307.573		

Note: B means unstandardized regression coefficient; Working days, working hours, and exercise time were incorporated into the regression model after being standardized; All model adjusted for gender, age, minorities, marriage status, regular diet, business socializing, drinking status, and smoking status.

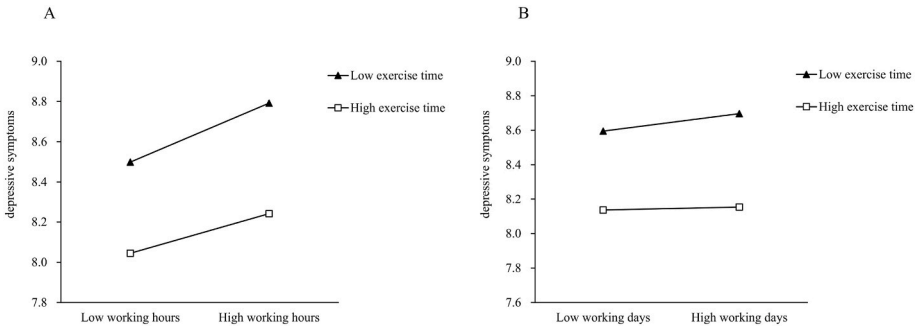

Fig. 3. The Moderating effect of exercise time on the relationship between working hours (A) and working days (B), and depressive symptoms.

3.5. Moderating effects of exercise frequency on work intensity and depressive symptoms

The model examining the effect of exercise frequency and work intensity on depressive symptoms was significant (Model 1 in Table 5). Exercise frequency was significantly related to depressive symptoms ($B = -0.287$, $t = -29.582$, $p < 0.001$); as exercise frequency increased, depressive symptoms decreased. Similar to the previous results, both working days and working hours were positively correlated with depressive symptoms ($B = 0.036, 0.114$; $t = 3.241, 9.538$; all p values were <0.01).

Similar to the previous regression analysis, there were significant interaction effects between exercise frequency and work intensity (working hours and working days) on depressive symptoms (Model 2 and Model 3 in Table 5). Exercise frequency alleviated the effect of working hours and working days on depressive symptoms ($B = -0.050, -0.035$; $t = -5.530, -3.916$; all p values were <0.001).

Similar to the previous simple slopes analysis (Fig. 4A), at high levels of exercise frequency, high work hours were associated with higher levels of depressive symptoms ($B = 0.067$, $t = 4.591$, $p < 0.001$), but the effect was more pronounced at low levels of exercise frequency ($B = 0.166$, $t = 10.907$, $p < 0.001$). In Fig. 4B, at the level of low exercise frequency, high working days were associated with higher depressive symptoms ($B = 0.073$, $t = 4.994$, $p < 0.001$), but there was no significant effect at the level of high exercise frequency ($B = 0.002$, $t = 0.154$, $p = 0.877$).

3.6. Moderating effects of exercise duration on work intensity and depressive symptoms

The model examining the effect of exercise years and work intensity on depressive symptoms was significant (Model 1 in Table 6). Exercise duration was significantly related to depressive symptoms ($B = -0.273$, $t = -27.966$, $p < 0.001$); as exercise duration increased, depressive symptoms decreased. Similar to the previous results, both working days and working hours were positively correlated with depressive symptoms ($B = 0.036, 0.126$; $t = 3.175, 10.535$; all p values were <0.01).

There were significant interaction effects between exercise years and work intensity (working hours and working days) on depressive symptoms (Model 2 and Model 3 in Table 6). Exercise year alleviated the effect of working hours and working days on depressive symptoms ($B = -0.028, -0.020$; $t = -3.054, -2.150$; p values were all <0.05).

Simple slope analysis showed that the relationship between working hours and depressive symptoms became stronger as exercise years

Table 5
Regression analysis for the effects of work intensity (working days and working hours), exercise frequency and their interaction on depressive symptoms.

Variables	Model 1			Model 2			Model 3		
	B	t	P	B	t	P	B	t	P
Working days	0.036	3.241	0.001	0.035	3.140	0.002	0.037	3.339	<0.001
Working hours	0.114	9.538	<0.001	0.117	9.774	<0.001	0.114	9.560	<0.001
Exercise frequency	−0.287	−129.582	<0.001	−0.291	−29.910	<0.001	−0.287	−29.556	<0.001
Working hours × Exercise frequency	–	–		−0.050	−5.530	<0.001	–	–	–
Working days × Exercise frequency	–	–		–	–	–	−0.035	−3.916	<0.001
R^2	0.063			0.064			0.064		
F	337.796			319.843			318.885		

Note: B means unstandardized regression coefficient; Working days working hours, and exercise frequency were incorporated into the regression model after being standardized; All model adjusted for gender, age, minorities, marriage status, regular diet, business socializing, drinking status, and smoking status.

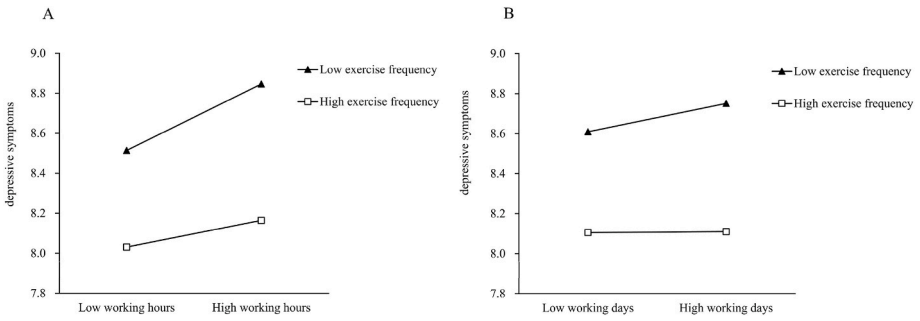

Fig. 4. The Moderating effect of exercise frequency on the relationship between working hours (A) and working days (B), and depressive symptoms.

Table 6
Regression analysis for the effects of work intensity (working days and working hours), exercise year and their interaction on depressive symptoms.

Variables	Model 1			Model 2			Model 3		
	B	t	P	B	t	P	B	t	P
Working days	0.036	3.175	0.001	0.035	3.105	0.002	0.036	3.189	<0.001
Working hours	0.126	10.535	<0.001	0.126	10.606	<0.001	0.126	10.532	<0.001
Exercise year	−0.273	−27.966	<0.001	−0.273	−28.014	<0.001	−0.272	−27.839	<0.001
Working hours × Exercise year	–	–	–	−0.028	−3.054	0.002	–	–	–
Working days × Exercise year	–	–	–	–	–	–	−0.020	−2.150	0.032
R^2	0.062			0.062			0.062		
F	331.610			312.731			312.436		

Note: B means unstandardized regression coefficient; Working days, working hours, and exercise year were incorporated into the regression model after being standardized; All model adjusted for gender, age, minorities, marriage status, regular diet, business socializing, drinking status, and smoking status.

decreased (Fig. 5A). Compared with low exercise years, high exercise years mitigated the effect of high work hours on depressive symptoms ($B = 0.154, 0.099$; $t = 10.156, 6.633$; p values were all <0.001). When the independent variable was working days (Fig. 5B), at the level of low exercise years, high working days were associated with higher depressive symptoms ($B = 0.055$; $t = 3.816$; $p < 0.001$); similarly, there was no significant effect at the level of high exercise years ($B = 0.016$; $t = 1.103$; $p = 0.270$).

4. Discussion

4.1. Relationship between work intensity and depressive symptoms

Most of our findings were consistent with our hypotheses. The results showed that both working hours and working days were positively correlated with depressive symptoms and were significant predictors of depressive symptoms. These findings were similar to previous research, which found that employees with higher levels of work intensity were more likely to report depressive symptoms (Choi et al., 2021; Virtanen et al., 2018; Zadow et al., 2021).

As far as we are aware, the relationship between work intensity and depressive symptoms is complicated. From the perspective of pathophysiology, high work intensity may shorten the rest time of employees, thus affecting their sleep quality and physical health and further increasing the psychological burden of employees (Liu, Wang, Wang, Ji, & Li, 2021; Schleupner & Kuehnel, 2021). From a psychosociological perspective, high work intensity is accompanied by high levels of work stress, which are widely known to be associated with depressive symptoms among employees (Choi et al., 2021; Yoon, Ryu, Kim, Kang, & Jung-Choi, 2018). The overtime work environment under high-intensity work might also induce the psychological distress of employees directly as a situational effect. For instance, employees may be embarrassed and feel shame and guilt about leaving the workplace alone while others, especially their supervisors, are still working (Ishida, Murayama, & Fukuda, 2020). Furthermore, these positive correlations might also be related to the high work engagement environment, where employees might be more likely to ignore their own depressed mood, leading to more severe depressive symptoms (Zadow et al., 2021). According to the theory of effort-reward imbalance, high work engagement without the desired reward or social support in the workplace can lead to an increased risk of depressive symptoms among employees (Siegrist, 1996; Yoon et al., 2018).

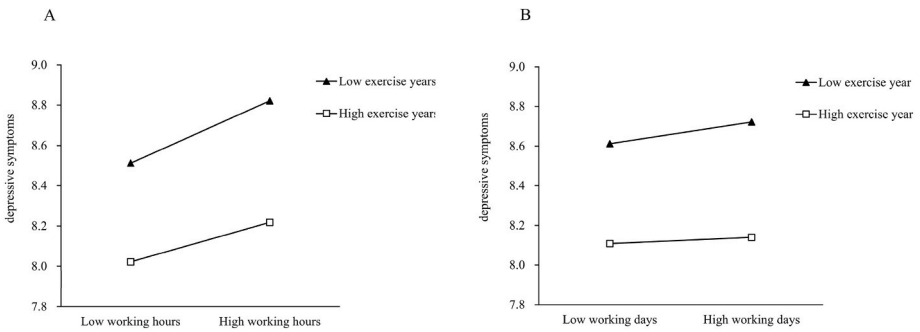

Fig. 5. The Moderating effect of exercise year on the relationship between working hours (A) and working days (B), and depressive symptoms.

4.2. Relationship between PA and depressive symptoms

PA levels were negatively related to depressive symptoms; the more active or consistent employees were in PA, the lower their reported depressive symptoms. These findings aligned with previous research, which found that people who exercised regularly, at least 1–2 times per week, tended to experience fewer depressive symptoms than those who did not or who exercised sometimes (Hallgren et al., 2020). Existing physiological mechanisms suggest that PA not only elicits changes in brain neuroplasticity but also reduces the level of proinflammatory factors and enhances the ability to resist oxidation and physiological stress, thus reducing the occurrence of depressive symptoms (Kandola, Ashdown-Franks, Hendrikse, Sabiston, & Stubbs, 2019; Soares, Reis, Rodrigues, Ribeiro, & Pereira, 2021). The effect of PA on depressive symptoms can also be moderated through social psychology. For instance, the connection between social ties and better mental health outcomes has been well established (Kawachi & Berkman, 2001); therefore, PA could enhance social support by providing opportunities for interaction and sociability to buffer against depressive symptoms (Harvey et al., 2018). Moreover, PA could increase feelings of euphoria by enhancing self-esteem and self-efficacy, which could reduce the risk of depressive symptoms (Kandola et al., 2019). PA can also have a positive effect on health behaviors associated with depressive symptoms, such as sleep. Studies have shown that PA was associated with decreased levels of sleep problems and depressive symptoms, and the association between PA and depressive symptoms was partly mediated by sleep problems (Kaseva et al., 2019).

4.3. Moderating effects of PA on work intensity and depressive symptoms

Our predictions that PA levels would modulate the effect of work intensity on depressive symptoms were supported. Different levels of PA alleviated the effect of working hours or working days on depressive symptoms after adjusting for potential confounders. That is, higher work intensity was associated with increased depressive symptoms among employees with lower levels of PA. We also found that both PA and work intensity were predictors of depressive symptoms, which was consistent with the literature (Virtanen et al., 2018). PA improves employees' ability to cope with the stress of high-intensity work and makes them feel better when working (Dishman et al., 2021; Mutz et al., 2020; X. Yang et al., 2010). Continued participation in PA could modify the relationship between chronic work stress and depressive symptoms, thereby reducing depressive symptoms related to work stress.

However, this moderating effect was more pronounced for the variable of working hours. In our research, as the levels of PA increased, the positive feedback effect of working hours on depressive symptoms gradually decreased. In addition, not participating in PA and less exercise time, frequency or years could enhance the positive influence between working days and depressive symptoms. Surprisingly, in this sample, we did not observe that regular participation in PA, higher exercise time, or frequency or years could ease the connection between working days and depressive symptoms. Meanwhile, our findings were in accordance with prior results, and it appeared that higher working hours were more associated with depressive symptoms than higher working days (Date et al., 2009). These findings further suggest that regular PA, higher exercise time or frequency or years have a greater moderating effect on the positive effects of working hours on depressive symptoms compared with working days. We speculated that, compared with the increase in weekly working days, long daily working hours could make employees concentrate their rest time each week, but they would be in a state of increased energy consumption every day, and their free time after work would decline, which would not be conducive to regular exercise. Working overtime every day also increases negative feelings frequently, which increases the risk of depressive symptoms (Ishida et al., 2020). Another reason for the difference could be that daily working hours might be more strongly correlated with job satisfaction, which is an important contributor to depressive symptoms (홍성태 & 양노열, 2014). However, the specific mechanism remains to be proven.

4.4. Future research direction and shortcomings

The main strength of this study was the investigation based on a large sample population, which makes our results more representative. However, several limitations should be addressed. First, the cross-sectional design of the study limits the causal interpretation of the findings. Second, although we controlled for some confounding factors, a number of important potential confounding variables, such as type of work, shift work, job autonomy, motivation, and controllability, which affect work intensity, were still not measured (Choi et al., 2021; Zadow et al., 2021). A few studies have suggested that job control and social support factors seem to be more associated with depressive symptoms than working time (Uchida & Morita, 2018). In our study, work intensity was more focused on time, and we divided it into two categories, average working days per week and average working hours per day. In recent years, the 996 work system which requires employees to work from 9 a.m. to 9 p.m. and 6 days every week, has become ubiquitous in Chinese enterprises and gradually evolved into the implicit culture of enterprises (Xiao, Silva, & Zhang, 2020). This is a large difference from the legal five-day workweek and 8-h workdays, which could leave employees with less time for PA and prone to negative emotions, such as depressive symptoms (Rugulies et al., 2021). The levels of PA have a greater moderating effect on the positive effects of working hours on depressive symptoms than working days. Future research should examine the interaction between working hours and PA and depressive symptoms in employees. Third, different intensities and areas (occupation, transportation, leisure exercise) and forms (individual or group) of PA seem to have different effects on depressive symptoms, but our study only focused on individuals' regular exercise and adherence (Aguilar et al., 2021; Elbe et al., 2019; Hamer, Stamatakis, & Steptoe, 2009). One study found that leisure time PA was the only physical activity domain associated with lower depressive symptoms (Aguilar et al., 2021). Future research can also carry out detailed discussions on PA to help employees better choose the type, intensity, and time of exercise and reduce the impact of negative emotions brought by high-intensity work. Fourth, our dataset only used self-diagnosed depressive symptoms, which limited us to examining depressive symptoms rather than medical diagnoses. Future studies may consider selecting a more mature depressive symptoms scale to further verify our research results or developing a new scale suitable for screening depressive symptoms of Chinese employees. Finally, previous studies have shown that the negative effects of long working hours on mental health may also be moderated by gender, socioeconomic status, job resources, education level, personality traits, and other variables (Choi et al., 2021; Parent-Lamarche & Marchand, 2019; Tsuno et al., 2019). Therefore, future research needs to rule out these confounding factors, which are strongly associated with work intensity and depressive symptoms.

5. Conclusion

Our findings suggest the importance of PA in buffering the depressive symptom effects of work intensity among employees. In particular, this moderating effect seems to be even greater when considering working hours. Enterprises should pay more attention to the physical and mental health of employees, arrange their working hours reasonably, and encourage them to take an active part in exercise to create greater benefits for the company. A workplace PA program might be a good idea to address these issues.

Authors' contributions

Conceptualization, J.W.; methodology, J.W. and R.X.; software, R.X.,

G.G., C.Z., and X.D.; validation, J.X.; formal analysis, T.D., J.W., J.X., R. X., and Y.D.; investigation, J.W., P·Y., and Y·W.; resources, J.W.; data curation, R.X., G.G., C.Z., X.D., and J.X.; writing-original draft preparation, T.D.; writing-review and editing, Y. D; visualization, T.D.; supervision, J.W.; project administration, J.W.; funding acquisition, J.W. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Declaration of competing interest

All the authors declare that there is no conflict of interest between of them.

Data availability

Data will be made available on request.

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