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Influence of workplace exercise on workers' cognitive performance

Influência da ginástica laboral no desempenho cognitivo de trabalhadores

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ABSTRACT | Introduction: Occupational tasks require physical and cognitive efforts. Within this context, workplace exercise seems to be a promising intervention to improve physical capacity. However, little is known about the influence of workplace exercise on cognitive performance. **Objectives:** This study aimed to evaluate the influence of workplace exercise on cognitive performance in administrative office workers. **Methods:** This cross-sectional study included 16 workers who performed workplace exercise training and 14 workers who did not (control group). The assessments were conducted after 3 months of workplace exercise training (stretching exercises, two to three times/week, 10-15 minutes/day). Physical activity level was assessed with the short form of International Physical Activity Questionnaire, while cognitive performance was assessed using computerized versions of Stroop color-word test and Corsi block-tapping test. **Results:** There was no significant difference between the groups in any Stroop test phases or in Stroop interference (349.3 ± 103.52 vs. 416.0 ± 129.7 ms; 5.37 ± 2.11 vs. 10.12 ± 6.55 %error; $p > 0.05$). No difference was found in Corsi test sequence of blocks (5.50 ± 0.82 vs. 5.57 ± 0.76 blocks) or in the total score (45.19 ± 15.96 vs. 46.93 ± 15.93 points; $p > 0.77$). **Conclusions:** The results of this study suggest that 12 weeks of workplace exercise training does not improve the cognitive performance of office workers.

Keywords | physical exercise; cognition; executive function; training; memory.

RESUMO | Introdução: Atividades ocupacionais demandam esforços físicos e cognitivos. Nesse sentido, a ginástica laboral parece ser uma atividade que pode promover ganhos físicos interessantes dentro do ambiente de trabalho. Entretanto, pouco se sabe sobre a influência dessa atividade sobre o desempenho cognitivo. **Objetivos:** O objetivo do presente estudo foi avaliar a influência da ginástica laboral no desempenho cognitivo de trabalhadores de setores administrativos. **Métodos:** Estudo transversal, no qual foram avaliados 16 funcionários praticantes de ginástica laboral e 14 funcionários não praticantes (grupo controle). As avaliações aconteceram após 3 meses de aplicação do programa de ginástica laboral (atividade de alongamento, duas-três vezes/semana, 10-15 minutos/dia). Foram avaliados o nível de atividade física e o desempenho cognitivo utilizando-se o teste de Stroop e bloco de Corsi. **Resultados:** Não houve diferença significativa ($p > 0,05$) entre os grupos em nenhuma das fases do teste de cores de Stroop e no efeito Stroop (349,3 ± 103,52 vs. 416,0 ± 129,7 ms; 5,37 ± 2,11 vs. 10,12 ± 6,55 %erro), bem como na sequência de blocos acertados (5,50 ± 0,82 vs. 5,57 ± 0,76 blocos) e no escore total dos blocos de Corsi (45,19 ± 15,96 vs. 46,93 ± 15,93; $p > 0,77$ pontos). **Conclusões:** Os resultados do estudo sugerem que 12 semanas de ginástica laboral não exercem influência sobre o desempenho cognitivo dos trabalhadores.

Palavras-chave | exercício físico; cognição; função executiva; ginástica; memória.

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INTRODUCTION

Routine work in administrative offices seeks to implement standardized and efficient organizational processes in an effort to improve the quality of services and time management. However, this may impose a constantly high workload on workers, often without breaks, and trigger problems related to interpersonal relationships and the musculoskeletal system.[1] This scenario favors a decline in functional performance as a consequence of factors such as lack of motivation, dissatisfaction, and damage to health, including tendonitis, repetitive strain injury (RSI), cumulative trauma disorder (CTD), and work-related musculoskeletal disorder (WRMD).

In addition, occupational tasks require great cognitive effort, sometimes even greater than physical effort. Thus, executive functions seem to play an important role in those tasks because they require dealing with aspects such as planning, working memory, multitasking, and/or ambiguities.[2] In this regard, the executive functions refer to a series of mental processes needed to perform a task while being concentrated and avoiding automatic, intuitive, or instinctive actions.[3] In occupations such as that of office workers, this ability becomes particularly important because of the presence of complex cognitive processes such as problem-solving and decision-making.

Workplace exercise (WE) is a form of intervention that can be conducted at work, characterized by the performance of a series of exercises including stretching, motor coordination, muscle strength, and relaxation in the workplace during the working hours. This intervention aims to prevent work-related injuries, normalize bodily functions, and provide some relaxation and socialization for workers.[4-6] WE can be classified, according to the time of its performance, as preparatory, compensatory, relaxing, or corrective.[1] An advantage of this intervention is to break routine work, which contributes to alleviate stress and the demand for productivity. Regarding psychosocial aspects, WE has shown positive effects on quality of life, including decreases in depression and anxiety symptoms, work-related discomfort, and sedentary behavior.[6] Regarding physical aspects, improved posture, decreased pain,[4] prevention of occupational diseases, and increased flexibility, strength, and coordination have also been reported.[7-9]

It is noteworthy that studies have shown that physically active people present better cognitive performance when compared to sedentary people.[10] Additionally, both acute[11,12] and chronic[13] exercise programs have been shown to improve cognitive performance. However, most studies had their exercise interventions conducted at specialized places such as gyms.[2,10-12,14,15] Conversely, despite the importance of cognitive function for occupational performance, especially for those working in offices, no study has investigated the potential effects of WE on cognitive performance. Therefore, this study aimed to evaluate the influence of WE on executive functions and visuospatial working memory in office workers. In view of the above, WE may have a positive influence on cognitive performance.

METHODS

STUDY DESIGN

This cross-sectional study consisted of two different sessions for evaluation purposes. In the first session, participants provided demographic information and completed a questionnaire about physical activity levels. In the second session, they performed cognitive tests on a computer. All tests were administered only after three months of WE training. The assessments were conducted at the participants' workplace.

SAMPLE

Thirty employees (13 men and 17 women) aged 21 to 65 years, working in different administrative departments in a federal university president's office in Brazil, and who had performed their duties for at least 1 year were evaluated. The WE group was composed by 16 workers and those who did not participate in WE sessions were included in the control group (n = 14). The general characteristics of the sample are shown in Table 1. Participants in the WE group who attended at least 70% of sessions were included in the analysis. Participants were excluded from the sample or from data analysis in case of voluntary withdrawal, nonparticipation in any step of the study, or any impossibility of data analysis. All participants were informed about the objectives and procedures of the study and signed an informed consent form. This study followed all ethical standards set by the Declaration of Helsinki and was approved by the Institutional Ethics Committee (CAAE: 30412214.5.0000.5537).

PHYSICAL ACTIVITY LEVEL ASSESSMENT

The International Physical Activity Questionnaire - short form (IPAQ-SF) was used to assess the usual level of physical activity.[16] The questions address weekly time spent on moderate- and vigorous-intensity physical activities, as well as daily time spent sitting (working days and weekends). The questionnaire was self-administered, and any questions the participants had were properly answered.

COGNITIVE PERFORMANCE ASSESSMENT

A computerized version of the Stroop color-word test (TESTINPACS®)[17] was used to measure processing speed and inhibitory control (Figure 1A). There are always two response options in the test, which can be chosen using the left (<) and right (>) arrow keys on the keyboard. The test has three phases, consisting of 12 trials in each of them, always with two response options: 1) congruent trial – the individual should indicate the color contained in a rectangle with the response corresponding to its name; 2) neutral trial - the individual should indicate the name of the color written in white ink; and 3) incongruent trial – the individual should indicate the ink color and ignore the color name written (word interference). Response time (RT) and accuracy results were recorded in a Microsoft Office Excel® spreadsheet. RT for correct responses only and percentage of correct responses were considered for analysis. Additionally, based on the difference in RT

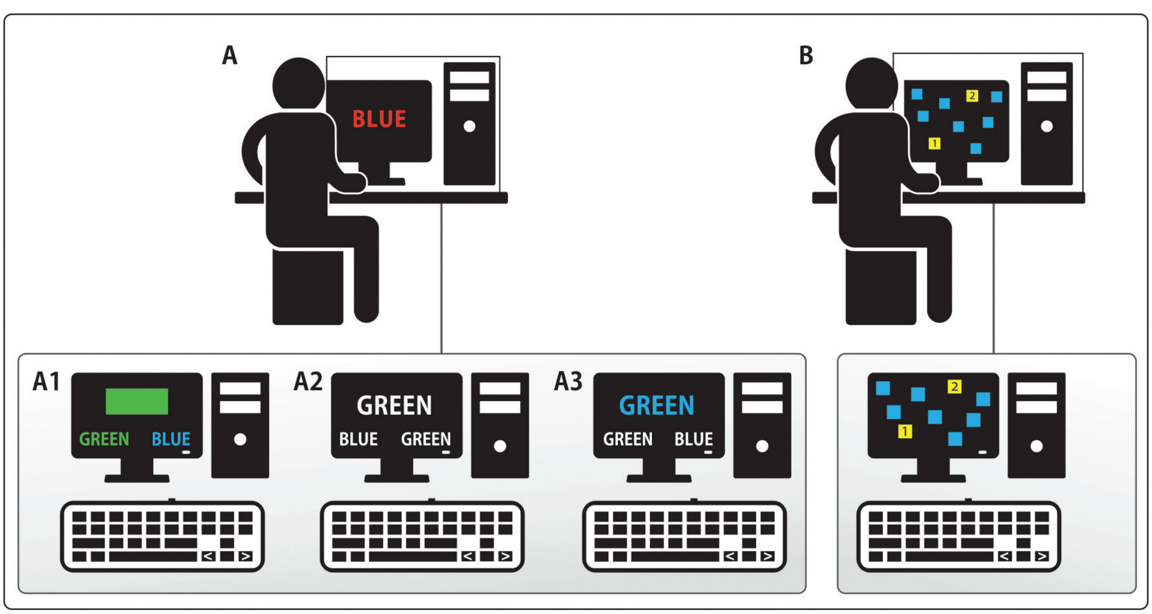

Figure 1. Graphical representation of the cognitive tests used in this study. Panel A represents the Stroop color-word test and its congruent (A1: the color of the rectangle should be associated with its respective name. Response = green), neutral (A2: the name of the written color should be associated with its correspondent. Response = green), and incongruent (A3: the ink color should be considered, and the name of the written color ignored. Response = blue) trials. The arrow keys on the keyboard (< or >) were used to provide responses. Panel B shows the Corsi block-tapping test, in which nine rectangles are randomly distributed on the screen and light up, one at a time, for 1 second. After the last rectangle turns off, the participant should click on those that lit up in the same order that was shown, using the mouse.

and the number of errors between the incongruent and neutral trials, Stroop effect or interference was calculated as a measure of the inhibitory control. Prior to the administration of the test, participants were verbally informed about the test objectives and procedures and had three chances to familiarize with the test.

A computerized version of the Corsi block-tapping test was used to assess visuospatial working memory.[18] The Corsi test consists of a set of nine blue blocks on a black background, arranged randomly on the screen (Figure 1B). Then, some blocks light up (turn yellow) in a given sequence, each one remaining lit up for approximately 1 second. After the last block turns off, the participant should click on the blocks in the same order that was shown. The test starts with a sequence of two blocks, and then one block is added as the participant progresses (e.g., 2, 3, 4, n...). The participant has two chances for each sequence of blocks. The test is completed when two errors are made in the same sequence. The number corresponding to the longest sequence of blocks correctly repeated, and the total score (sequence x number of correctly repeated sequences) were used for analysis.

DESCRIPTION OF WORKPLACE EXERCISE SESSIONS

WE sessions were held at a federal university president's office in Brazil. The WE program was part of a large institutional project for the university employees called "Living in Harmony," which aimed to directly improve the employees' lifestyle. WE sessions occurred two to three times per week, lasting 10 to 15 minutes, with a total of 30 sessions over 3 months. Exercises involved predominantly stretching routines using only body movements, without the aid of any equipment.

STATISTICAL ANALYSIS

The Shapiro-Wilk test was used to assess the normality of data distribution. The data were reported as mean and standard deviation (SD). The t-test for independent samples was used to compare the general characteristics of the sample and the outcome variables between the groups (RT and percentage of correct responses in the Stroop test and sequence and score in the Corsi test). Hedges g was used as a measure of effect size, which is more suitable for samples <20 individuals.[19] Hedges g was calculated by dividing the difference between the groups' means and pooled and weighted SD [g = (M1-M2)/pooled and weighted SD]. Effect size magnitude was interpreted as follows: "trivial" (< 0.20), "small" (0.20-0.59), "moderate" (0.60-1.19), "large" (1.20-1.99), and "very large" (≥ 2.0), as recommended by Hopkins et al.[20] A p-value < 0.05 was considered statistically significant. The data were analyzed with the aid of SPSS, version 20.0.

RESULTS

Table 1 shows the general characteristics of the sample. There was no difference in age, anthropometric variables, or physical activity level between the groups. Participants in the WE group attended 79.8% of sessions on average.

Regarding the outcome measures, no significant differences were found in RT between the groups (Figure 2A), with a trivial effect size magnitude for the congruent (g = 0.014) and incongruent (g = 0.003) phases, and a small magnitude in the neutral phase (g = 0.203). Although there was no statistically significant difference in accuracy (Figure 2B), there was a small effect magnitude in the three Stroop test trials (g = 0.477, g = 0.384, and g = 0.339 for phases 1, 2, and 3, respectively). Similarly, there was no significant difference in the Stroop effect for RT (Figure 2C) or for the percentage of additional errors made (Figure 2D); however, the magnitude of the effect size for the Stroop interference was moderate (g = 0.718 and g = 0.904, respectively). Additionally, there was no significant difference in the visuospatial working memory performance for sequence of blocks (WE group: 5.50 ± 0.82 vs. control group: 5.57 ± 0.76; g = 0.086) and for total score (WE group: 45.19 ± 15.96 vs. control group: 46.93 ± 15.93; g = 0.065) between the groups (p = 0.77).

DISCUSSION

This study evaluated the influence of WE on executive function and visuospatial working memory in administrative office workers. There were no statistically significant differences between the groups in both cognitive domains. To the best of our knowledge, this was the first study to assess the influence of WE on workers' cognitive performance, which prevents direct comparisons with studies focused on WE.

Possible explanations for the findings include factors related to the characteristics of the exercise (type, duration, and intensity) and the duration of the intervention. WE is a light-intensity activity that consists of a stretching routine without the aid of any equipment, with a weekly frequency of two to three sessions. Most studies showing positive effects of exercise on cognition used moderate-intensity activities.[10,21,22] Therefore, it is likely that the physiological demand (e.g., intensity) in WE is too low

Table 1. General characteristics of the workplace exercise (WE) group and the control group

Variables	WE group (n = 16)	Control group (n = 14)	P-value
Age (years)	41.63±14.26	37.64±11.77	0.42
Body mass (kg)	65.25±9.86	68.85±16.00	0.46
Height (m)	1.67±0.07	1.62±0.10	0.10
Body mass index (kg.m^{-2})	23.20±2.35	25.89±4.64	0.05
Time spent walking (min.wk^{-1})	100.3±93.6	226.4±219.4	0.06
Time spent on moderate-intensity activity (min.wk^{-1})	127.2±105.1	129.3±140.5	0.96
Time spent on vigorous-intensity activity (min.wk^{-1})	73.12±125.5	97.5±138.8	0.62
Time spent sitting (h.day^{-1})	6.81±2.26	8.14±2.77	0.16

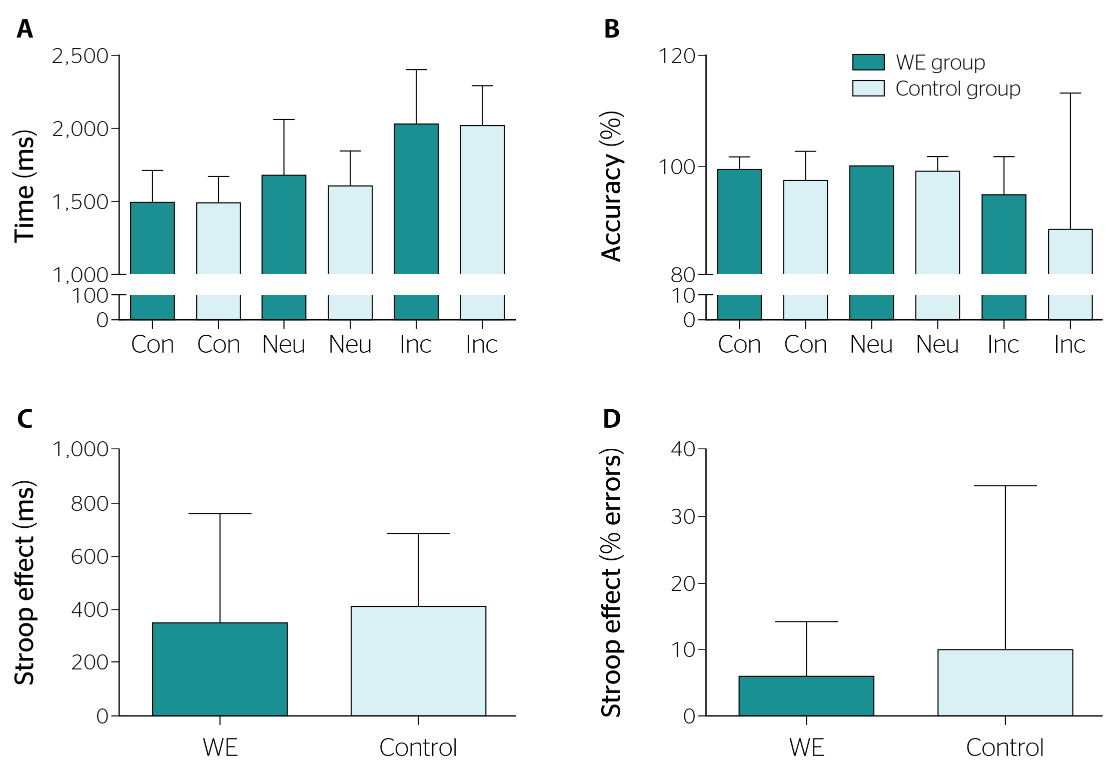

Figure 2. Comparison of response time (RT) (A) and percentage of correct responses (B) in the congruent (Con), neutral (Neu), and incongruent (Inc) trials, as well as the Stroop effect or interference on RT (C) and percentage of additional errors (D) obtained by the difference between the incongruent and neutral trials of the Stroop color-word test between the workplace exercise (WE) and the control groups.

to lead to significant changes in cognition. These results suggest that a minimum exercise intensity threshold to induce short- and long-term cognitive benefits may exist.

Another factor that may have influenced the results concerns adherence to the training sessions, which is related to monthly training volume. Participants in the WE group attended about 70% of sessions, and only three participants reached 90% attendance rate. This means that most participants attended approximately 20 sessions out of the 30 exercise sessions provided, which means a low total training volume. It is worth noting that low adherence to physical activity programs is not an exclusive problem of physical activity interventions in the workplace, as they are common even in specialized spaces for exercise promotion such as gyms. Soares et al.[5] found a paradox; while 96% of employees recognized that WE could be beneficial, 83% did not participate in WE sessions. Workers are indeed resistant to WE training. For example, in the present study, the distribution of participants in each group was based on convenience (they could choose the group), as several workers refused to participate in the WE sessions. Therefore, future studies should seek to use strategies to increase workers' involvement and adherence to WE programs.

Importantly, the usual level of physical activity is positively associated with brain function and structure.[2,21] Additionally, it has been suggested that time spent on sedentary activities (e.g., activities involving very low energy expenditure, < 1.5 metabolic equivalents), such as sitting or lying down during the waking period, as most administrative job requirements, leads to detrimental effects at different levels, including cognitive effects.[24] It is worth noting that both groups were considered physically active, as they reached more than 150 minutes of moderate- or vigorous-intensity physical activity per week[25] and had similar sitting times during the day. Therefore, the habitual physical activity of the participants in this study may have influenced the results, and the WE intervention, the way it was performed, may have promoted little or no additional effect on cognitive function. However, cognitive performance is influenced not only by physical activity but also by a range of factors such as gender, age, family history, educational level, smoking, head trauma, ethnicity, diet, mental stress, and socialization,[26] which were not controlled for in this study.

Although there was no significant difference between the cognitive variables, the magnitude of the effect on inhibitory control was moderate, which suggests the possibility of a positive effect of WE on this cognitive domain. The literature has shown the benefits of WE for other outcomes, such as low back pain,[4] quality of life, depressive symptoms, back pain, self-esteem,[6] and motor coordination.[9] Furthermore, encouraging workers to do physical activity is important because of benefits for both personal and work-related spheres. For example, Pedersen et al.[27] conducted an exercise intervention at the workplace over the course of a year which resulted in reductions in systolic blood pressure, percentage of body fat, shoulder and back pain, as well as increases in muscle strength and cardiopulmonary capacity. Therefore, interventions such as WE represent an excellent cost-benefit relationship for both companies and the employees.

The limitations of this study include its cross-sectional nature, which prevents from establishing a causal relationship, and the fact that the study setting was not a controlled environment, since the assessments were performed in the workplace. Also, the use of stretching exercises alone, the short intervention duration, the short duration of WE session, and the low weekly frequency may not have been sufficient to result in a significant difference. Conversely, the strengths of the present study include its originality, since no previous investigation sought to examine the possible cognitive effects of WE, and its high ecological validity, given that both the intervention and the assessments were carried out in the actual workplace of the participants. Additionally, validated computerized cognitive tests were used, which ensures high precision of the dependent variables. Future studies should consider using a longitudinal design, which will allow the evaluation of possible changes experienced by the participants induced by WE, as well as other physical exercise modalities in the workplace.

CONCLUSION

Although 3 months of WE was not associated with significant differences in the workers' cognitive performance, the effect size of the difference between the groups, particularly on inhibitory function, was moderate. Importantly, there is a relatively consistent body of knowledge demonstrating the benefits of WE for factors such as prevention and treatment of occupational diseases, decreased pain, and improved coordination. Therefore, despite the null results of this study, WE is recommended because of other benefits that can be obtained. We suggest that WE interventions include other types of activity besides stretching, such as aerobic exercises or muscle strengthening using body mass or elastic bands, in addition to a longer session duration.

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