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The Acute Effects of Aerobic Dance Exercise with and without Face Mask Use on Attention, Perceived Exertion and Mood States

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ABSTRACT

The present study aimed to determine the effect of wearing a face mask during aerobic dance exercise on cognitive function, more specifically on attention, as well as on perceived exertion and mood states. Thirteen healthy college students (9 males and 4 females: mean age = 17.5 years, height = 1.72 m, weight = 71.00 kg) volunteered to participate in this study. They were randomized to perform aerobic dance exercise while wearing a cloth face mask or no mask or a control condition (sitting on a comfortable chair and reading information about the health benefits of aerobic dance exercise) on three separate occasions (with at least one week of interval). Rate of perceived exertion (RPE), the Brunel Mood Scale (BRUMS) and d2 Attention assessment were assessed before and immediately after each condition. The results demonstrated higher concentration performance for the aerobic dance exercise without face mask than the control condition ($p = 0.05$). Post RPE and BRUMS fatigue subscale values were significantly higher in the aerobic dance exercise with face mask as compared to the aerobic dance exercise without face mask and control condition (all, $p < 0.05$). BRUMS vigor subscale value significantly differed across conditions ($F = 113.84$, $p < 0.001$, $ES = 0.86$) and was significantly higher in the aerobic dance exercise group without face mask as compared to the aerobic dance exercise with face mask and the control conditions (both, $p < 0.001$). This study suggests that face mask use during aerobic dance exercise with moderate intensity did not affect attention. Practitioners, students and athletes should avoid wearing face mask while practicing physical activity or aerobic dance exercise with moderate intensity to improve its acute effect on cognitive function.

KEYWORDS

Cognition; mood; aerobic physical activity; physical education



1 Introduction

As of July 29, 2021, the widespread human-to-human “Coronavirus Disease 2019” (COVID-19) transmission has resulted in 197 million confirmed cases and 4.2 million deaths globally (WHO, Last update: July 29, 2021). The spread of COVID-19 has upset the normality of daily life, forcing entire populations to practice social distancing and perform self-isolation due to COVID-19 fear [1,2]. COVID-19 has also directly affected lifestyle behaviours resulting in reduced level of physical activity, increased sitting time, poor nutritional status [3–5], and mental health issues, including sleep problems [2,6,7]. Furthermore, these aforementioned studies indicating reduced physical activity level and/or prolonged sedentary behaviour have also shown that these changes in daily habits are linked to a greater risk of developing mental problems [3,5]. More specifically, in a Chinese adolescent population, better nutritional status and moderately active physical activity were observed to be connected with a lower likelihood of developing depression or anxiety, whereas highly active physical activity resulted in a lower level of depression, anxiety and insomnia [3]. Similar findings were replicated in another Chinese college student population, with lower depressive symptoms being associated with moderate-intensity physical activity [4]. A third study in a Chinese adolescent population confirmed that increasing physical activity levels and reducing sitting time acted as protective factors against anxiety, depression, and insomnia [5]. Therefore, regular physical activity is necessary to maintain mental health during the pandemic. Given that wearing a face mask is mandatory while exercising in public (gym) or doing occupational physical activity at workplace, it is an urgent need to address whether wearing a mask during physical activity or exercise has any negatively psychological consequences. However, very limited information is available regarding this topic [8,9].

Several studies have investigated the physiological impact of wearing face masks to exercise in different populations. It has been demonstrated that short term moderate-to-strenuous aerobic physical activity with a mask is feasible, safe, and associated with only minor changes in physiological parameters such as a mild increase in end-tidal carbon-dioxide [9], despite ventilation, cardiopulmonary exercise capacity and comfort being reduced when wearing surgical masks and highly impaired by FFP2/N95 face masks in healthy individuals [10]. Furthermore, a prolonged use of the face mask may negatively affect mental and cognitive performance given that the latter is associated with cerebral oxygenation and peripheral oxygen saturation [11], and thus may result in headaches [12] and hypoxia-induced cognitive impairment. However, regarding the effect of face mask use during physical activity or acute exercise on cognitive performance, contrasting results have been reported in the literature [13,14]. These different conclusions may be attributed to many factors such as recruited population, face mask type and exercise mode and intensity.

Regular moderate intensity exercise has numerous beneficial effects on physical and mental health [15]. Extensive research has shown that a single bout of exercise enhances executive functions (i.e., attention, working memory, cognitive flexibility and inhibitory control), relieve psychological symptoms such as mood, anxiety, and depression, and increase positive affect [15]. A meta-analysis shows that aerobic dance improves global cognitive function and memory [16], which may relate to dance training-induced brain plasticity [17]. Yet, dance has different styles, which require social interaction, emotional expression, sensory stimulation, and bodily movements with different intensity, duration, and frequency along with music [17]. Because of the limited body of literature addressing the impact of wearing a face mask and doing physical activities, including aerobic dance, or exercise at the same time, with inconsistent findings in terms of psycho-cognitive responses, further research is needed to be undertaken to fill in this gap in knowledge and reach a robust conclusion. Therefore, the aim of the present study was to examine the effect of wearing face mask during aerobic dance exercise, particularly free-style workout, on attention, as well as on perceived exertion and mood states. It was hypothesized that acute dancing with face masks would produce more negatively psychological responses compared to exercise without face masks.

2 Materials and Methods

2.1 Participants

Thirteen healthy (9 males and 4 females) college students (majoring in physical education with no-smoking history: mean age = 17.5 years, height = 1.72 m, weight = 71.00 kg) volunteered to participate in this study after being informed of the nature of the present investigation and its associated possible risks.

The sample size was calculated based on the effect sizes obtained in one of our previous publication (Cohen's D ranging from 1.0 to 4.7), a moderate correlation between measures, a power of 0.80, and an alpha error probability of 0.05. As such, the minimum number of participants was computed to be 6–9 [14].

Participants who presented the following condition(s) were excluded: (a) co-morbidities like diabetes, hypertension, epilepsy, cardiac illness, asthma, and other respiratory illnesses; whereas those presenting the following condition(s) were included: (b) physically active (doing regular or structured exercise program in or outside school(s) except for daily walking) from 48 h before the experimental conditions (as will be detailed below); and (c) refrain from coffee and any strenuous exercise 48 h before the days of any trial. This study protocol was approved by the university ethical committee and was conducted in accordance with the 1964 Declaration of Helsinki.

2.2 Protocol

The study was carried out with a randomized, crossover design. Four sessions were completed for each participant: One familiarization session, control session (during which participants were asked to sit on a comfortable chair and read information about the health benefits of aerobic dance exercise) and two aerobic dance sessions with and without wearing a mask. The last three sessions were conducted in random order. Each session took place at the same time of the day (± 1 h) with at least one-week interval between each of the two sessions. Of note, the cloth mask (Half and quarter masks, Tunisia) was a 3-layer comfortable elastic and extra-soft ear loop, which enables to eliminate pressure to the ears, with layers composed of non-woven fabric. This mask was considered as a face mask typically used by the general population [18].

During the first session, anthropometric data were collected, followed by familiarizing with the aerobic dance exercises. Additionally, the d2 test, Rating of Perceived Exertion (RPE) and the Brunel Mood Scale (BRUMS) were obtained at the two time points (15 min before and immediately after each session) across the two aerobic dance sessions (aerobic dance sessions with and without wearing a mask conditions) and control session in order to assess attention, perceived exertion and mood states.

The aerobic dance exercise routine consisted of four common dance movements performed within 40 min: A) marching with toe or heel touch on every 4th count; B) step touch and side jack; C) V-step and turn step; D) Grapevine. It was started and finished by 10 min warm-up and cool-down. The participants repeated 16 times per movement (approximately 5 min each) in the same previous order (A, B, C, and D) by using upper body/limb movements (e.g., putting the hands on the waist, or natural motions in the arms and head simultaneously while stepping). The music selection for the warm-up and the main workout were 120 and 140 beats/min using a CD player with a speed controller. The goal for peak intensity of the aerobic dance workout was for participants to achieve at between 60% and 70% heart rate reserve (HRR; defined by the Karvonen formula [19]). To confirm this intensity, heart rate was monitored at 5 s intervals throughout both dance sessions using a heart rate monitor Polar TF4 (Polar Electro, Finland).

2.3 Evaluations

2.3.1 Attention Assessment

The d2 test, consisting of 14 rows with 47 characters per line, was employed to quantitatively assess the level of concentrated visual attention of the recruited participants [20]. Characters used in this test are the letters “d” or “p”, with various dashes, from one to four, above and below each letter. Participants were

requested to scan each line and identify only the characters with the letter “d” and two dashes in a time span of 20 s. Two parameters were assessed: concentration performance (CP) and total number of errors (NE). CP is computed as the difference between d2-symbols that have been correctly and incorrectly marked, respectively. The total number of NE is calculated as the sum of errors made by the participants in identifying d2- and not d2-symbols. Both CP and NE were used for data analysis in the present study.

2.3.3 Rating of Perceived Exertion (RPE)

Perceived exertion was assessed by the RPE scale (Modified Borg Dyspnea scale) throughout the aerobic dance exercise. It ranged from 0 (no perceived effort like resting perception) to 10 (corresponding to maximal perceived effort = the most stressful exercise ever performed) [21].

2.3.4 Mood

Mood state was assessed using the BRUMS developed by Terry et al. [22]. Participants were asked to answer the question (“How do you feel right now?”) after each session. This scale contains 24 items within six sub-scales (4 items contributing to a sub-scale): anger, confusion, depression, fatigue, tension, and vigor. Each item is rated on a 5-point Likert scale (0 = not at all, 1 = a little, 2 = moderately, 3 = quite a bit, and 4 = extremely), leading to a maximum of 16 points per sub-scale.

2.4 Statistical Analysis

Statistical analysis were carried out by computing means and standard deviation (SD) for continuous variables. Normality of data distribution was verified by applying the Shapiro-Wilk test, which was preferred over other normality tests based on the sample size employed in the present study. Paired Student’s *t*-tests and analysis of variance (ANOVA) with repeated measures or their non-parametric versions, depending on the normality of data, were carried out, to capture differences (a) between baseline and post-intervention measurement and (b) across the three conditions. Effect size (ES) based on partial eta squared (η^2) was calculated to determine the main and interaction effects. The ES was considered small if $\eta^2 < 0.06$ and large if $\eta^2 > 0.14$. All statistical analyses were conducted utilizing the commercial software “Statistical Package for Social Sciences” (SPSS version 24.0, IBM, Armonk, NY, USA). *P*-value of less than 0.05 was considered statistically significant.

3 Results

Descriptive values are reported in Table 1 for CP, NE and RPE. Concerning CP, the interaction between time (before vs. after) \times trial was significant ($F = 19.63, p < 0.001, ES = 0.52$). Post hoc analyses revealed that CP was higher only during the aerobic dance exercise without face mask with respect to the control condition ($p = 0.05$) (Table 1). Regarding NE values, the interaction between time (before versus after) \times trial was marginally significant ($F = 17.10, p < 0.13, ES = 0.48$). Post hoc analyses revealed that NE was slightly higher for the control condition than the aerobic dance exercise without mask, but not statistically significant ($p = 0.06$).

RPE value differed across conditions ($F = 209.9, p < 0.001, ES = 0.92$) and was significantly higher in the aerobic dance exercise with face mask compared to the aerobic dance exercise without face mask ($p = 0.01$) and control condition ($p < 0.001$) (Table 1).

Regarding the BRUMS scale, fatigue ($F = 180.20, p < 0.001, ES = 0.90$) was significantly different across conditions, being higher in the aerobic dance exercise condition with face mask in comparison with the aerobic dance exercise without face mask and the control conditions (both, $p < 0.001$). Similarly, vigor domain/items significantly differed across conditions ($F = 113.84, p < 0.001, ES = 0.86$) and were significantly higher in the aerobic dance exercise group without face mask compared to the aerobic dance exercise with face mask and the control conditions (both, $p < 0.001$). Furthermore, no significant effect in terms of conditions regarding the other subscales of BRUMS (all, $p > 0.05$) could be detected.

Table 1: Values of CP, NE and RPE broken down according to the condition

Variable		Control condition	Aerobic dance exercise		Interaction time x group
			Without face mask	With face mask	
CP	Before	153.07 ± 18.29	151.92 ± 18.63	152.61 ± 19.86	$p < 0.001$
	After	155.30 ± 15.70	182.23 ± 15.17**#	176.38 ± 15.19**	
NE	Before	55.70 ± 18.30	56.84 ± 20.09	55.61 ± 20.65	$p = 0.13$
	After	53.46 ± 16.56	26.76 ± 14.82**	32.07 ± 15.02**	
RPE	Before	0.45 ± 0.48	0.61 ± 0.50	0.46 ± 0.51	$p < 0.001$
	After	0.53 ± 0.51	6.15 ± 0.68**#	7.23 ± 0.72**#£	

Note: CP: concentration performance, NE: total number of errors, RPE: Ratings of Perceived Exertion.

** Significant difference compared with before exercise at $p < 0.001$, * Significant difference compared with before exercise at $p < 0.05$, # Significant difference compared with the control condition at $p < 0.001$, £ Significant difference compared with aerobic dance exercise without face mask at $p < 0.05$.

4 Discussion

The present data showed that acute aerobic dance exercise, regardless of wearing a mask, increased attention, in term of CP and vigour subscale. However, dancing with face mask resulted in higher levels of perceived exertion and fatigue. Furthermore, both aerobic dance exercise with and without face mask use groups reported increased scores in focused visual attention tasks, with only aerobic dance exercise without facemask use group experiencing significantly greater improvement than the control condition. Like our study's results, a recent publication [13] demonstrated that wearing a face mask while practicing 45 min of mild-intensity exercise did not impact motor-cognitive performance. On the other hand, perceived dyspnea, presenting as 36% higher breathlessness, could be detected with respect to the control group. In contrast, another investigation explored the impact of wearing a cloth mask on cognitive function during 15 min physical warm-up [14]. Authors reported that physical warm-up while wearing a cloth face mask elicited greater improvement in attention than warm-up without face mask use. Contradictory findings of the literature may be explained taking into account methodological differences between studies, as various kinds of face mask were employed, fostering different levels of hypoxia. Also, studies differed in terms of experimental conditions such as the intensity of exercise and variables measured. These differences may explain some of the discrepancies reported, which warrants further research in the field.

Cognitive functions are multi-dimensional and include several aspects, such as working memory, attention, cognitive flexibility, and inhibitory control. These dimensions can be measured after 20 to 45 min of exercise to quantitatively assess cognitive performance and potential cognitive gains related to physical activity. de Greeff et al. [23] performed a systematic review of the literature with meta-analysis, pooling together 31 studies assessing the effects of physical activity on cognitive functions among pre-adolescents (aged 6–12 years). Authors reported significant improvements in terms of attention (effect size, ES, of 0.43 [95%CI 0.09–0.77]), executive functions (ES of 0.24 [95%CI 0.09–0.39]), and academic performance (ES of 0.26 [95%CI 0.02–0.49]). ESs were larger for interventional studies assessing continuous/chronic practice of physical activity. Kimura et al. [24] compared two types of aerobic dance exercise, free (FS) and combination (CB) style workouts, on executive function in elderly people. They reported that only CB has a dual-task nature and induces movement (task) interference with unexpected movement changes, which may lead to improved executive function. These findings are contradictory with our results that showed that FS aerobic dance exercise increased cognitive function, particularly in terms of CP. Some other studies have found that execution function (as assessed using the Stroop test and the Tower of London task), in terms of reaction time and inhibitory control, improved after resistance

exercise with respect to pre-exercise values and compared to no-exercise interventions [25–28]. According to another investigation, resistance exercise was able to enhance working memory as assessed by means of a modified Sternberg working memory task [29]. Nevertheless, the effect size and benefits of physical exercise vary depending on the exercise intensity, type of exercise and population. The potential advantages derived from short-term high-intensity exercise in terms of cognitive gains are contradictory [23]. Furthermore, the precise mechanisms potentially explaining these benefits have to be fully elucidated yet [17].

From a psychological perspective, the vigor-related subscale yielded greater values immediately after aerobic dance exercise without face mask but not with face mask with respect to control condition, resulting into elevated CP. Furthermore, other parameters like RPE and fatigue were found to be higher after aerobic dance exercise with face mask compared with no face mask use and control condition. This may be explained by accounting for several physiological parameters, like the consumption of exhaled CO₂ mechanically entrapped by the mask, which may lead to increased perceived exertion and fatigue.

The present study added new evidence on acute psychological responses to aerobic dance with face masks in comparison to without wearing masks. The findings may provide useful information in the real world. For example, physical educators or exercise instructors may explain the discomfort sensations resulted from wearing a face mask during exercise and encourage participants to overcome the difficulties. Some strategies might be employed to reduce the feelings of dyspnea and fatigue. Considering deep breathing is able to inhibit the sympathetic nerve system and activate the parasympathetic nerve system this technique seems effective to reduce the stress and alleviate hypoxia induced by wearing a mask. Furthermore, it is reasonable to remove face covering if physical distance is long enough during outcome practice.

This study has several limitations. First, we recruited young and healthy adults and thus findings may not be applicable to other populations (i.e., children, aged people, patients or individuals with medical conditions). Second, wearing a surgical face mask greatly lessened running performance because of the increased difficulty in breathing at higher intensities [8]. Future research is warranted to explore the psychological responses to different exercise regimens (i.e., types, intensities, and durations). Third, given that previous studies mostly focused on the impact of wearing face masks on physiological measures, both physical and mental changes were not the outcomes of the present study. Yet, future research may investigate the effect of exercise with face masks on physiological, psychological, physical variables simultaneously.

In conclusion, the present study showed that acute aerobic dance exercise without face mask (session lasting approximately 40 min) has a positive impact on attention, particularly concentration performance, and the mood state of vigor, despite that wearing face masks may result in an increase in perceived exertion and fatigue. Furthermore, face mask use during aerobic dance exercise with moderate intensity did not affect attention. Practitioners, students and athletes should avoid wearing face mask while practicing physical activity or aerobic dance exercise with moderate intensity to improve its acute effect on cognitive function. However, further research is warranted to replicate our findings in a statistically robust way and both short- and long-term effects of aerobic dance exercise should be studied. Also different populations should be explored.

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