A cloth facemask increased ratings of perceived exertion and reduced affect, but did not affect sprint or muscular performance during training in athletes

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All authors have agreed to submit this manuscript as a pre-print to SportRxiv.

Please cite as: Dantas, M., Barboza-Neto, R., Guardieiro, N.M, de Sá Pinto, A.L., Gualano, B. and Saunders, B. (2020). A cloth facemask increased ratings of perceived exertion and reduced affect, but did not affect sprint or muscular performance during training in athletes. *Sportrxiv*, doi: 10.31236/osf.io/bejzs

Abstract

During the COVID-19 pandemic, the necessity of using face masks during sports is likely balanced by coaches and athletes between the risk of infection and their impact on exercise performance. To inform this decision, we aimed to test the effects of wearing a cloth face mask on exercise performance and subjective responses during training of track and field athletes. Participants (n=10) performed two training sessions with and without a 3-layered cloth mask in a randomized, counterbalanced, crossover design. The training session was designed to simulate the specific demands of the sport that the athletes practiced. The sprint protocol consisted of performing five maximal 30 m sprints, with a passive 4-min interval between runs. Performance variables (sprint time, acceleration) were calculated using the sprint time data. Jump performance was assessed pre- and post-sprints using a countermovement vertical jump. Throughout the training session, ratings of perceived exertion (RPE) and affect were collected. There was no evidence of condition x time interactions for sprint time ($P=0.21$) or acceleration ($P=0.47$). There was weak evidence of an effect of condition ($P=0.05$) on RPE, though no evidence of a condition x time interaction ($P=0.35$). There was moderate evidence of a condition x time interaction ($P=0.02$) for affect, with lower ratings following sprints 3, 4 and 5 when using the mask. These findings suggest that wearing a mask may negatively impact subjective feelings of training without necessarily harming sprint performance. During an unmitigated epidemic such as in Brazil, the protection against SARS-CoV-2 infection associated with wearing a face mask appears to outweigh the increased discomfort and perception of effort related to this safety tool.

Key words: sports; COVID-19; SARS-CoV-2; risks; exercise

Introduction

The World Health Organization (WHO) declared a pandemic of the new coronavirus (SARS-Cov-2; Severe Acute Respiratory Syndrome Coronavirus 2) in March 2020. Several health policies have been adopted to prevent and slow infection rates, including the use of face masks (WHO, 2020). Face masks act as a physical barrier against contamination (5) and owing to the increased risk of community transmission of SARS-CoV-2 at fitness facilities (9), wearing a face mask has been recommended during exercise, including during high-intensity activities. Preliminary data suggest that the use of masks may impair aerobic performance (6). These findings were attributed to perceived discomfort associated with mask-wearing, since participants reported feeling increasingly short of breath and claustrophobic at higher exercise intensities while wearing a mask (Driver et al., 2021). Whether these data can be extrapolated to highly anaerobic sprint-based activities in trained populations remains unknown.

The use of masks during training and sports may be considered a relevant non-pharmacological intervention to prevent SARS-CoV-2 infections, particularly in places where community transmission remains largely unmitigated. One case in point is Brazil, which has been severely affected by the COVID-19 pandemic, accounting for over 500,000 reported deaths, which corresponds to 13% of deaths worldwide as of June 2021. In this scenario, the necessity of face masks during sports is likely balanced by coaches and athletes between the risk of infection and their impact on exercise performance. To inform this decision, this study aimed to test the effects of wearing a cloth face mask on exercise performance and subjective responses during training of sprint-based athletes.

Methods

Participants

A non-probabilistic sample of ten competitive track and field athletes (3 women, 7 men; age: 23 ± 4 y; height: 1.72 ± 0.10 m; body mass: 66.2 ± 10.7 kg) participated in this study via the extension project NASARE (Nucleus for Evaluation in Health and Sports Performance) at the Federal University of Rio Grande do Norte. The athletes must not have had any recent history of injury or rehabilitation (<3 months), no respiratory diseases (*e.g.*, asthma), must train for at least 90 min for 6 days a week, and participate in regional level competitions or higher. All athletes linked to NASARE and who met these criteria received an email with an invitation to participate, totaling 15 athletes. Those who responded were then invited to participate in an

online meeting during which they were informed of the testing procedures in detail. Those who were retained then completed an online informed consent form using Google Forms™. This study was first approved by the university's ethics committee. The ten included athletes consisted of six sprinters, three long jumpers, and one 110 meters hurdler competing in regional and national competition. Three of the sprinters were competing for the Brazil Athletics Trophy, Brazil's national athletics championships, one of which was the current Brazilian 100m sprint champion and another a member of the Brazilian U-20 team. Three more of the athletes had a good regional level, one being the number one of the North/Northeast, and the others among the top 8 in their region for their respective competitions.

Experimental design

Participants performed two training sessions with and without a triple-layered antiviral cloth mask (Fashion Masks, São Paulo, Brazil) in a randomized and counterbalanced crossover design. This type of mask was chosen because it is widely accessible, recommended to the general public by the WHO and appropriate for exercise, whereas surgical and N95 masks are not recommended to be worn during exercise (12). In the mask condition, athletes were required to keep the mask firmly in place over the nose, mouth, and chin during the entire session, except when drinking water. All athletes were habituated to wear a mask during their daily routines due to mandates, but not specifically during their training sessions.

The training session was designed together with the coaches to simulate the specific demands of the sport that the athletes practiced so that it met specific objectives and was based upon plyometric and educational training to improve technical movements (Table 1). Throughout the training session, ratings of perceived exertion and perceived affect were collected. All participants were familiar with all aspects of the testing protocols since they were habitual included in their training regimes.

Table 1. Outline of the training session.

Training component	Exercise	Volume
Warm-up	Joint mobility	3 min
	Light running	10 min
	Dynamic flexibility	5 min
	Running	10 min

Specific training	Countermovement jump	1 attempt
	Sprint training	5 x 30 m (4 min rest)
	Countermovement jump	1 attempt

Sprint (5 x 30 m) and countermovement jump protocols

The sprint protocol consisted of performing five maximal 30 m sprints, with a passive 4-min interval between runs, performed on an outdoor running track (temperature: $27.52 \pm 1.52^\circ\text{C}$, relative humidity: $79.8 \pm 9.6\%$). The players were positioned behind a line marked by cones, and times were recorded using a handheld timer by two experienced coaches. Acceleration was calculated using the sprint time data. Countermovement jumps were measured using a jump mat connected to the Jump Test Pro 2.10 software (Cefise®, Brazil). Jump performance was assessed using the countermovement vertical jump described previously (4). The countermovement jump was performed from a static position, with feet parallel and without the aid of the arms, performing a partial squat as a way to enhance the jump height. The best jump height (cm) of three attempts was recorded as the outcome measure.

Ratings of perceived exertion and feeling scale

Participants were familiarized with the Borg CR100 scale which has been shown to be valid for measuring exercise intensity (8), before rating their perceived exertion prior to the repeated sprint protocol, and following each sprint. The basic positive or negative affective valence (*i.e.*, the 'pleasure' or 'discontent' of what individuals feel) was assessed using the affect scale (11), which is a validated scale to measure basic affect during physical exercise. The feeling scale is an 11-point bipolar scale, composed of negative valences including: -5=very bad, -3=bad, -1=reasonably bad; positive valences including: +5=very good; +3=good and +1=reasonably good; and 0 being neutral. Participants were familiarized to the scale and provided detailed information as to its meaning, namely that affective valence is defined as the subjective feeling of "goodness" or "badness" felt during the exercise that occurs independently of emotions. Affect was recording at identical moments to CR100.

Data analysis

Data were analyzed using the SAS statistical package (SAS® University Edition, SAS Institute Inc., USA), and are presented as mean $\pm$ SD. The CMJ (maximum jump height) was analyzed using a mixed model assuming condition (2 levels; MASK and CON) and time (2 levels; pre-

and post-exercise) as fixed factors. Sprint performance (time, acceleration), RPE and affect were analyzed using a mixed model assuming condition (2 levels; MASK and CON) and sprint number (5 levels; 1-5) as fixed factors. Individuals were assumed as a random factor for all mixed models. Tukey-Kramer adjustments were performed when a significant F value was obtained. Data normality was determined using the Kolmogorov-Smirnov test; normality was assumed for RPE and affect. Results were interpreted according to the statistical probabilities of rejecting the null hypothesis (H_0) in the following categories: $P \geq 0.1$: no evidence against H_0 ; $0.05 \leq P < 0.1$: weak evidence against H_0 ; $0.01 \leq P < 0.05$: moderate evidence against H_0 ; $0.001 \leq P < 0.01$: strong evidence against H_0 ; $P < 0.001$: very strong evidence against H_0 (1, 3).

Results

There was no evidence of a main effect of condition ($P=0.93$), time ($P=0.17$) or a condition x time interaction ($P=0.21$) for sprint time (Figure 1, Panel A). There was no evidence of a main effect of condition ($P=0.83$), time ($P=0.37$) or a condition x time interaction ($P=0.47$) for acceleration (Figure 1, Panel B).

A

B

Figure 1. Sprint times (Panel A) and accelerations (Panel B) for each repeated sprint in MASK (clear bars) and CON (shaded bars).

166 There was no evidence of a main effect of condition ($P=0.85$), time ($P=0.21$) or a condition x
167 time interaction ($P=0.42$) for CMJ (Figure 2).

168
169 **Figure 2. Jump height for the countermovement jump in MASK (clear bars) and CON (shaded bars).**

170
171 There was weak evidence of an effect of condition ($P=0.05$) on RPE, as well as very strong
172 evidence of a time effect ($P<0.001$), though no evidence of a condition x time interaction
173 ($P=0.35$) (Figure 3, Panel A). There was strong evidence of an effect of condition ($P=0.006$)
174 and time ($P=0.0002$) on affect, and moderate evidence of a condition x time interaction
175 ($P=0.02$; Figure 3, Panel B). Post-hoc analysis revealed moderate to strong evidence that affect
176 was different following the 3rd ($P=0.04$), 4th ($P=0.01$) and 5th ($P=0.005$) sprints compared to the
177 1st in MASK, but not in CON. There was weak to moderate evidence that affect following
178 Sprint 3 ($P=0.03$), 4 ($P=0.08$) and 5 ($P=0.01$) was different between MASK and CON.

A

B

Figure 1. Sprint times (Panel A) and accelerations (Panel B) for each repeated sprint in MASK (clear bars) and CON (shaded bars). a = main effect of condition, b = significantly different from Sprint 1, c = significantly different from CON at the same time point.

Discussion

The results of this study showed that sprint performance and countermovement jump pre- and post-sprints were unaffected by wearing a mask. Nonetheless, ratings of perceived exertion and

affect were negatively impacted by the mask. These data suggest that wearing a mask may negatively impact upon subjective feelings of training without necessarily harming performance.

Our data contrast with others showing detrimental effects of wearing a mask in exercise performance (6) although support the conclusions of a recent meta-analysis that showed no effects of wearing a surgical or N95 mask on exercise performance (14). Some studies assessing the impact of masks on performance have used laboratory protocols, particularly cardiopulmonary tests, whose applicability to real-world scenarios are disputable. The impairment in physiological variables including $\text{VO}_{2\text{peak}}$, heart rate and ventilation responses does not necessarily translate into reduced exercise performance during a practical training session, such as the one tested in the current study. This might be particularly true for trained athletes such as those here, who are more familiar with strenuous exercise routines and may cope better with the potential physiological disturbances associated with wearing a mask during exercise, without any detriment to exercise performance. This seems to be case in this study, as the athletes were able to maintain their performance, irrespective of the altered perception of effort and negative affect from wearing the mask.

Ratings of perceived exertion is commonly used for training load control in several sports and is used for training prescription by coaches (7, 10). Indeed, RPE appears to be an appropriate measure of internal training load in athletes that can be used to determine different phases within a training cycle (13). Previous studies have shown a negative relationship between RPE and physical fitness adaptations, showing that greater perception of effort, and subsequently training load, was harmful to performance (2). Although using a mask here did not negatively impact upon performance, there was an increase in RPE and affect which might artificially inflate the estimated training load of the session. Coaches and athletes should be aware that wearing a mask can increase perception of effort and reduce exercise enjoyment, although sprint and muscular performance may not be affected.

One of the major strengths of this study is that we evaluated well-trained track and field athletes during their competitive season, meaning they will likely have been very close to peak performance, and in their usual environment, during a typical training session in hot weather, which likely makes wearing a mask more challenging. Nonetheless, the exercises performed

here were specific to the type of activity required for these athletes and extrapolation of these results should be confined to similar sprint protocols to that employed. It is unclear if other repeated sprint protocols, with less recovery time between sprints, might have shown different results. Also, from a practical standpoint, longer sessions likely requires changing the mask when it becomes wet, which did not occur in this study. Unfortunately, we could not obtain physiological measures during exercise, such as VO_2 or heart rate, due to restrictions enforced by the coaches since they did not wish for us to interfere with the training session any further. Nonetheless, a recent meta-analysis suggested that surgical and N95 masks do not influence physiological measures during exercise (14), which suggests we may have shown similar results here.

In conclusion, sprint and countermovement jump performance during training were unaffected by wearing a mask, although ratings of perceived exertion and affect were negatively impacted. These data suggest that wearing a mask may negatively impact upon subjective feelings of training without necessarily harming performance.

Practical recommendations

The current data suggest that sprint athletes can train with a cloth mask safely in the knowledge that it can reduce transmission rates of airborne viral diseases such as COVID-19 and is unlikely to negatively impact upon their training quality. Nonetheless, coaches should be aware that athletes may not enjoy the training session to a similar extent when wearing a mask, and that using session RPE to evaluate the intensity of training when wearing a cloth mask might not accurately reflect performance during the session. During an unmitigated pandemic, the protection against SARS-CoV-2 infection associated with wearing a face mask appears to outweigh the increased discomfort and perception of effort related to this safety tool.

245 **Acknowledgments**

246 The authors would like to thank all of the athletes for taking part in this research. The authors
247 received no specific funding for this work. B.S. (2016/50438-0) has been financially supported
248 by Fundação de Amparo à Pesquisa do Estado de São Paulo and has also received a grant from
249 Faculdade de Medicina da Universidade de São Paulo (2020.1.362.5.2).

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