BRIEF RESEARCH REPORT

Facemask Use During Graded Exercise Testing in the COVID-19 Pandemic: Minimal Concern

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ABSTRACT

Background: Graded exercise testing (GXT) is a fundamental component of the diagnosis/treatment of patients with suspected/known cardiovascular disease (CVD). Amid the current pandemic, patients must wear a facemask during GXTs, yet the impact of facemask use on peak values from a GXT has not been evaluated in individuals at increased risk of developing CVD. The objective is to examine potential differences in peak values obtained from a GXT performed under facemask versus no facemask conditions among adults at increased risk for CVD.
Methods: Using a randomized, crossover study design, 16 adults at moderate risk for developing CVD completed 2 trials (facemask versus no facemask). Peak speed, grade, heart rate (HR), and rating of perceived exertion were recorded during a Modified Bruce Treadmill GXT for each trial. Peak speed and grade were used to estimate peak oxygen consumption ($\mathrm{V{\scriptstyle O}_2}$peak) and peak metabolic equivalents of task ($\mathrm{V{\scriptstyle O}_2}$peak/3.5).
Results: Total exercise time (17:10 ± 2:04 versus 15:58 ± 1:51 minutes, $P = 0.0005$), peak HR (170 ± 11 versus 164 ± 11 b·min^{-1}, $P = 0.01$), estimated $\mathrm{V{\scriptstyle O}_2}$peak (42.3 ± 8.9 versus 36.8 ± 6.6 mL·kg^{-1}·min^{-1}, $P = 0.005$), and peak metabolic equivalents of task (12.2 ± 2.6 versus 10.5 ± 1.9, $P = 0.005$) were higher during the no facemask versus the facemask trial. Peak rating of perceived exertion was similar between trials (18.1 ± 1.3 versus 18.3 ± 1.2, $P = 0.84$).
Conclusion: Facemask use had a significant but modest clinical impact on hemodynamic responses during a GXT among moderate risk adults. *J Clin Exerc Physiol*. 2023;12(1):18–21.

Keywords: cardiorespiratory fitness, exercise stress test, coronavirus disease 2019, cardiovascular disease

INTRODUCTION

Graded exercise testing (GXT) is a fundamental component of the diagnosis and treatment of patients with suspected/known cardiovascular disease (CVD) (1). A maximal/near maximal effort from patients is essential for diagnosing/excluding the presence of cardiac ischemia, assessing disease prognosis, and prescribing exercise intensity in cardiac rehabilitation programs to maximize improvements in cardiorespiratory fitness (CRF). Importantly, a submaximal effort could lead to a false negative diagnosis for ischemia and delay/prevent treatment (2,3). Amid the coronavirus disease (COVID-19) global pandemic, many patients have been required to wear a facemask during general GXT (without gas collection) (4,5). While cardiopulmonary exercise testing is the gold standard for determining exercise capacity, clinics more commonly use a general GXT due to available resources and cost (6,7). Available data have focused almost exclusively on impact of facemask use on GXT values among young, healthy adults. Therefore, it remains unclear whether facemask use during a general GXT impacts

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peak values (and thus diagnosis, prognosis, and/or treatment) of individuals at increased risk of developing CVD. Therefore, this investigation aimed to compare peak values derived from a GXT between facemask versus no facemask use in adults at moderate risk of developing CVD.

METHODS

Study Design and Participants

Using a randomized crossover study design, we examined the effects of facemask versus no facemask use on peak GXT values from 16 males (n = 9) and females (n = 7). *Moderate risk* was defined as male ≥ 45 years or female ≥ 55 years and/or at least 2 CVD risk factors (e.g., hypertension and hypercholesteremia) (8). Ten participants were classified as regular exercisers (i.e., ≥150 minutes of planned moderate-intensity exercise per week). Potential participants were excluded if they were pregnant, classified as high risk for CVD or COVID-19 based on Centers for Disease Control and Prevention guidelines, or physically could not walk on a treadmill (9). Written informed consent was obtained from all participants prior to testing procedures. All procedures were approved by the Central Michigan University Institutional Review Board.

Experimental Procedures

Participants completed 2 GXTs, using the Modified Bruce Protocol, separated by 1 week, and at the same time of day. Participants were instructed to refrain from consuming a large meal and caffeine within 4 and 24 hours, respectively, before testing. Participants took their current medications as prescribed (no participant reported taking a beta-blocker). While wearing light clothing, participants' height and weight were determined using a stadiometer and weight scale (Seca 213/700, Seca Precision for Health, Hamburg, Germany), respectively. Heart rate (HR) was determined from a 12-lead electrocardiogram (Quinton Q-Stress, Version 4.0.1.458 SP1; Mortara Instrument, Inc., Milwaukee, Wisconsin). Blood pressure (BP) was monitored using a stethoscope and standard sphygmomanometer by the same exercise physiologist during both GXTs. Participants wore their own self-selected mask (surgical, single layer cloth, and double layer cloth) over their nose and mouth throughout each GXT. Rating of perceived exertion (RPE) using the Borg 6-20 Scale, oxygen saturation (SpO_2) measured via finger pulse-oximetry (ZacUrate, 500BL; Stafford, Texas) (9). HR and BP were recorded at the end of every stage and at peak. Twelve-lead electrocardiogram was monitored throughout the GXT. After the GXT was completed, participants completed a 5-minute active recovery (treadmill walking). A standard script was used during each GXT encouraging participants to continue if possible. Predicted maximum HR (=220 − age) was estimated using the participant's age (10). Peak rate pressure product (Peak RPP = peak HR × peak SBP) was calculated based on patients' peak HR and systolic BP (SBP) (11). Estimated peak oxygen uptake (Vo_2peak) was calculated using the grade and speed from the final stage of exercise the participant completed ≥2 minutes of exercise using American College of Sports Medicine running (Vo_2 $mL \cdot kg^{-1} \cdot min^{-1} = (0.2 \cdot S) + (0.9 \cdot S \cdot G) + 3.5$) and walking ($Vo_2$ $mL \cdot kg^{-1} \cdot min^{-1} = (0.1 \cdot S) + (1.8 \cdot S \cdot G) + 3.5$) equations (8). Functional Capacity (peak metabolic equivalents of task [METs] = Vo_2peak/3.5) was calculated based on participants' estimated Vo_2peak (8).

Statistical Analysis

A paired *t* test was used to determine potential differences between facemask versus no facemask experimental trials. All statistical analyses were performed using SimgaPlot 12.5 (Systat Software Inc., San Jose, California). A *P* value of <0.05 was considered statistically significant. All data are presented as means ± SD.

RESULTS

Participant characteristics are presented in Table 1. No significant difference in resting HR, SBP, diastolic BP (DBP), or SpO_2 were detected between trials (Table 2). Time to exhaustion was significantly shorter during the facemask versus no facemask trial (15:58 ± 1:51 versus 17:10 ± 2:05 minutes, $P < 0.001$). Additionally, peak speed (3.5 ± 0.5 versus 3.9 ± 0.6 mph, $P = 0.004$) and grade (14.3 ± 1.2 versus 15.1 ± 1.5%, $P = 0.004$) were significantly lower during the facemask versus no facemask trial. Consequently, estimated Vo_2peak was significantly lower by, on average, an estimated 5.5 ± $mL \cdot kg^{-1} \cdot min^{-1}$ (Table 2, $P = 0.005$) and peak METs were significantly lower by an average of 1.7 METs (Table 2, $P = 0.005$) during the facemask (versus no facemask) trial. Peak HR was also significantly lower during the facemask versus no facemask trial (Table 2, $P = 0.01$), as was percent predicted maximum HR (Table 2, $P = 0.03$). However, no differences were observed between the facemask and no facemask trials for RPE, RPP (30,961 ± 3,246 versus 30,819 ± 4,474, $P = 0.80$), peak SBP (187 ± 19 versus 182 ± 14 mmHg, $P = 0.10$), or peak DBP (Table 3). Nine participants exhibited exercise-induced unifocal/multifocal premature ventricular complexes when exercising with a facemask, and 7 of these participants exhibited unifocal/multifocal premature ventricular complexes during the no

TABLE 1. Participant characteristics.

Variable	Males (n = 9)	Females (n = 7)
Age (y)	58.1 ± 4.4	56.4 ± 2.1
Body weight (kg)	99.5 ± 12.8	77.6 ± 27.1
Height (cm)	185.1 ± 7.9	170.0 ± 6.9
BMI ($kg \cdot m^{-2}$)	29.1 ± 3.4	26.4 ± 7.3
Medication statins (n)	2	0
Hypertension (n)	5	0
High cholesterol (n)	2	1
Nonexercisers (n)	3	3

BMI = body mass index. Data presented as mean ± SD or as a count (n) of the column count.

TABLE 2. Resting values during the no facemask and facemask trials.

Variable	No Facemask	Facemask	*P* Value
Heart rate (b·min^{-1})	83 ± 10	82 ± 9	0.57
Systolic blood pressure (mmHg)	116 ± 15	114 ± 11	0.26
Diastolic blood pressure (mmHg)	68 ± 11	67 ± 10	0.61
SpO_2 (%)	97 ± 5	97 ± 2	0.47

SpO_2 = peripheral oxygen saturation.

facemask trial. During the facemask trial only, 2 participants exhibited ST segment depression, and 1 displayed a hypertensive response at peak exercise.

DISCUSSION

The overall objective of this study was to evaluate the impact of wearing a facemask on peak values obtained from GXT, among individuals at moderate risk of developing CVD. We found facemask use during a GXT resulted in modest, significantly lower differences in diagnostic and prognostic information derived from GXT results.

Modestly lower peak HR (170 versus 164 b·min^{-1}) was observed when participants wore a facemask during a GXT. Furthermore, participants achieved >100% of age-predicted maximum HR during each trial, far exceeding 85% of age − maximum predicted HR (criteria for chronotropic assessment) (12). Notably, while participants in the current investigation were at moderate risk of CVD, they were otherwise healthy, and most were regular exercisers. Therefore, a higher risk and/or less physically active population may respond differently to facemask use during a GXT (13).

Albeit modest, the lower peak HR observed during the facemask trial should be considered when developing exercise prescriptions. Accurate assessment of peak HR is essential for exercise prescription and progression in cardiac rehabilitation programs to optimize improvements in CRF) (14). A lower peak HR during a GXT could result in prescribing lower exercise intensities in cardiac rehabilitation and attenuate the anticipated benefits of exercise training on CRF (8). Therefore, clinicians should keep in mind the impact of facemask use on peak HR during GXT and consequently exercise prescription.

Shorter total exercise time and peak functional capacity were observed when participants completed the GXT with a facemask. Peak values were estimated based on time to exhaustion and workload (i.e., speed and grade) at fatigue. GXT protocols using 3-minute stages (e.g., the Modified Bruce Protocol) require patients to complete ≥2 minutes of their final stage to predict the MET level of that stage (8). We found participants exercised 1 minute shorter when wearing a facemask during a GXT, translating to nearly 2 METs lower than the no facemask trial. In addition to prognosis and treatment strategy (e.g., risk stratification for advanced heart failure therapies), accurate assessment of peak METs is essential for determining patient ability to return to work after a cardiovascular event (15). Notably, the standard error in estimating exercise capacity from prediction equations is ±1 MET (16). Therefore, clinicians should consider alternative testing methods available (i.e., cardiopulmonary exercise testing) for accurate assessment of functional capacity when necessary.

Interestingly, peak RPE (valid measure of exercise intensity) was comparable between trials (17). Therefore, participants subjectively felt a similar effort was achieved in both trials. Peak RPP was also similar between trials, indicative of equal myocardial oxygen demand and cardiovascular stress. However, peak HR and METs were lower during the facemask trial. This is meaningful, considering clinicians rely on patients to provide feedback regarding their effort at fatigue.

There are certain limitations of our investigation. For example, participants were not blinded to test type. However, they were blinded to exercise time and physiological data, helping to reduce participant bias. We also only used the Modified Bruce Protocol, while other protocols (e.g.,

TABLE 3. Peak values during the no facemask and facemask trials.

Variable	No Facemask	Facemask	*P* Value
Estimated Vo_2peak (mL·kg^{-1}·min^{-1})	42.3 ± 8.9	36.8 ± 6.6	<0.01
Peak METs	12.2 ± 2.6	10.5 ± 1.9	<0.01
Peak HR (b·min^{-1})	170 ± 11	164 ± 11	0.01
MPHR (%)	104.0 ± 6.2	101.1 ± 6.1	0.03
Time to exhaustion (min:s)	17:10 ± 2:04	15:58 ± 1:51	<0.01
RPE	18.1 ± 1.4	18.3 ± 1.2	0.58

HR = heart rate; METs = metabolic equivalents of task; MPHR = maximum predicted HR; RPE = rating of perceived exertion.

Naughton or Bruce) are employed for some patients. However, as a widely used protocol in the U.S., the Modified Bruce Protocol is applicable in clinical situations (8). Furthermore, additional outside exercise prior to participants completing their GXT was not controlled. However, this is more applicable to real-world scenarios, as clinicians cannot fully control a patient's outside activity (e.g., cardiac rehabilitation exercise session) prior to exercise testing. While our participant pool was composed of predominantly fit individuals, participants had a variety of CVD risk factors and exhibited abnormal stress test responses, representing what would typically be seen in general populations. Additionally, our participant pool comprised nearly equal males and females, and ~20% were of a nonwhite race.

CONCLUSIONS

Our results suggest facemask use slightly attenuates peak HR and workload data derived from a maximal GXT, which may impact clinical decision making. Therefore, clinicians should be aware of the impact of facemask use, or lack thereof, on patient data during exercise testing.

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