SWACSM Abstract

Impact of Mask Wearing on Post-Exercise Hemodynamics

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ABSTRACT

As the guidelines regarding COVID-19 regressed, many fitness centers established regulations requiring mask-wearing during exercise. Data suggest that the impact of a mask during exercise has minimal effects on exercise hemodynamics. The post-exercise period has been described as a window of opportunity to lower blood pressure, a phenomenon called post-exercise hypotension. The impact of wearing a mask on post-exercise hemodynamics is unknown. **PURPOSE**: The purpose of this study was to examine the impact of mask-wearing during exercise on post-exercise hemodynamics. **METHODS**: Nine total participants aged 18-30 yr were recruited for this experimental cross-over study. This within-subject design involved six randomized conditions; control no mask, no exercise (CON-NE), control-surgical mask, no exercise (CON-SUR), control-exercise, no mask (CON-E), exercise surgical mask (EXS-SUR), exercise N95 mask (EXS-N95), and exercise cloth mask (EXS-CL). The exercise protocol was a HIIT 4 x 4 on a cycle ergometer. Participants exercised at 85% of VO2max for four minutes, followed by a three-minute rest period, repeated four times. Measurements of cardiac output (Q), stroke volume (SV), heart rate (HR), systemic vascular resistance (SVR), and brachial blood pressure (BP) were measured pre-exercise for 20-min, during exercise, and postexercise for 60-min. **RESULTS:** Exercising at high intensity with the surgical, cloth, and N95 masks showed no statistically significant differences in HR, systolic BP, diastolic BP, SV, SVR, and RPE during exercise when compared to the CON-E condition (all $p > 0.05$). Post-exercise data revealed no statistical differences in systolic BP or diastolic BP compared to the CON-E condition (both $p > 0.05$). HR was significantly lower (roughly 4-5 ± 1.8 bpm $p < 0.01$) in the CON-E group compared to all exercise mask-wearing groups following exercise. Additionally, SV ($p<0.001$) and Q ($p=0.002$) were significantly lower in the EXS-N95 group compared to the other exercise groups. **CONCLUSION**: This study is consistent with current literature in suggesting that mask-wearing during exercise, even at high intensity, has no effect physiologically during exercise and on post-exercise hemodynamics. The impact of wearing a mask during exercise may alter the mechanisms of post-exercise hypotension.

EXPANDED ABSTRACT

As quarantine guidelines began to lessen, many health centers worldwide reopened under new COVID guidelines.[1] Because virus particles in respiratory droplets may be transmitted to a greater extent during different forms of physical exertion,[2, 3] especially indoor settings,[4, 5] face masks have become part of these new guidelines.[6] A recent narrative review[7] and meta-analysis[8]

concluded that wearing a face covering during exercise had minimal impact on physiological outcomes and performance measures. These reviews, however, contained few studies that included high-intensity exercise. Additionally, they reported only a few studies measuring blood pressure (BP) during exercise, and only two measured cardiac output (Q).

Moreover, the post-exercise period has been highlighted as an opportunity to maximize cardiovascular health outcomes.[9] Specifically, following an acute exercise session, BP reduces without any symptomatic clinical hypotension; this is a phenomenon termed “Post-Exercise Hypotension” (PEH).[10] PEH has clinical relevance as the magnitude of reduction has been shown to predict chronic training responses, and this reduction has been shown to last upwards of 16 hours following exercise.[11] There are no data on the effects of mask-wearing during exercise on post-exercise hemodynamics. Thus, the purpose of this study is two-fold: first, to assess the impact of different masks on exercise hemodynamics during high-intensity exercise, and second, to assess the impact of different masks on post-exercise hypotension.

METHODS

Healthy Participants aged 18-30 yr were recruited for this experimental cross-over study. The study was a randomized cross-over experimental design with six conditions (Control-no exercise (CON-NE), control-surgical mask (CON-SUR), control-exercise (CON-E), exercise surgical mask (EXS-SUR), exercise N95 mask (EXS-N95), and exercise cloth mask (EXS-CL)). Participants completed eight visits to the lab at Grand Canyon University.

Visit one consisted of informed consent administration, health history screening, and BP measurement familiarization. Lack of familiarization with BP assessments has been highlighted as a weakness in the post-exercise hypotension literature.[12] All participants were asked to go through a "run-through" of the cardiovascular assessments to ensure that they are comfortable and understand the research protocol.

During visit two, participants then completed baseline assessments as described. Anthropometric measures of body weight, height, waist, and hip circumferences were taken. Body

composition was determined via whole-body air displacement plethysmography (Bod Pod, COSMED). Bod Pod has been shown valid when compared to underwater weighing.[13] The participants had their BP measured again after anthropometric and body composition assessments. Participants were then asked to complete a VO_{2max} assessment—participants completed at ergometer ramp protocol.

Following visit two, all participants were randomly assigned to complete each of the six conditions one week apart. All visits were conducted at the same time of day to account for the diurnal impact on the outcome variables. To prepare for the assessments, participants will be fasted for at least five hours, refrain from caffeine and alcohol for 24 hours, and avoid unaccustomed physical activity 24 hours before their visit. Additionally, participants will be asked to avoid antihistamines for five days and oral vitamin C supplementation three days before each visit to mitigate these agents' actions on the vasculature. Instructions were given to consume the same dinner and amount of fluids the night before and the morning of the laboratory visits. Participants recorded their meals to ensure compliance with this requirement.

The six conditions consisted of control-exercise (CON-E; no mask-wearing but will still exercise), control no exercise (CON-NE; no mask-wearing and no exercise), CON-SUR; (no exercise but mask-wearing), exercise while wearing surgical masks (EXS-SUR), exercising wearing N95 masks (EXS-N95), and exercise wearing cloth masks (EXS-CL). Besides the CON-NE and CON-SUR conditions, the remaining conditions were identical, with the only difference being the mask worn. On the two ‘no-mask’ wearing days, participants did not be wear a mask during the “pre-exercise” assessments or “post-exercise” assessments. Upon arrival at the laboratory, the participants were asked to lie supine for 20 min to achieve hemodynamic stability. Following this, "pre-exercise" measurements of brachial BP (SphygmoCor XCELTM, AtCor Medical, Sydney, NSW, Australia[14, 15]), Q, and SVR was assessed (PhysioFlowTM; Manatec Biomedical, Paris, France[16]).

Following these "pre-exercise" assessments, participants were directed to a cycle ergometer and asked to participate in a high-intensity exercise session. The specific protocol was a 4 x 4 protocol that has been widely adopted.[17] Participants performed a light warm-up for 3 minutes, then increased the intensity to elicit 80-95% of VO2max and stayed at this intensity for four minutes. A three min active recovery followed. This will be repeated four times. Ratings of perceived exertion (RPE), HR, Brachial BP, Q, and SVR were measured following every high-intensity bout during exercise.

After the cooldown, participants' brachial BP was measured every five min for 60 minutes following the exercise. Q and SVR were measured continuously for 60 min following the exercise. Participants duplicated the above protocol four times, once while wearing no mask (CON-E), a surgical mask (EXS-SUR), (EXS-N95), and a cloth (EXS-CL) mask. During and post-exercise data were analyzed using ANOVA to compare the mean between group values.

RESULTS

Nine young (20.3 ± 1.5) participants with an average BMI of 28.5 ± 7.5 kg/m^2 completed the study. Table 1 details that during exercise, there was no statistically significant difference between any mask-wearing exercise group and CON-E on outcomes of HR, SBP, DBP, SV, CO, SVR, or RPE (all $p > 0.05$). During the post-exercise measurement phase, there was no statistically significant difference between CON-E and the other mask groups on outcomes of systolic BP ($p = 0.264$), diastolic BP ($p = 0.06$), or SVR ($p = 0.155$). There were significant group differences on outcomes of HR ($p < 0.001$), SV ($p < 0.001$), and Q ($p = 0.002$) (See table 1).

Table 1. Group hemodynamic differences during and post-exercise

During Exercise	**CON-E**	**EXS-SUR**	**EXS-CL**	**EXS-N95**	**P-Value**
HR (bpm)	172.4 ± 11.0	171.4 ± 12.5	177.9 ± 8.7	177.0 ± 10.4	0.564
SBP (mmHg)	160.1 ± 25.5	159.5 ± 22.7	165.9 ± 24.4	157.4 ± 21.7	0.913
DBP(mmHg)	70.1 ± 12.5	69.2 ± 8.7	67.0 ± 10.8	74.5 ± 7.4	0.986

SV (ml/min)	101.9 ± 43.1	84.9 ± 47.5	106 .6 ± 44.1	99.5 ± 42.1	0.073
Q (L/min)	13.9 ± 6.7	12.0 ± 7.2	14.2 ± 6.7	13.8 ± 5.9	0.249
SVR (Dyn.s/cm^5)	1941.7 ± 4424.5	3174.5 ± 6485.6	1269.9 ± 2601.3	1311.2 ± 4033.7	0.123
RPE	15.5 ± 1.8	15.4 ± 1.2	16.0 ± 2.0	15.6 ± 1.7	0.516
Post-exercise					
HR (bpm)	75.3 ± 11.6[a]	81.5 ± 13.6	83.3 ± 12.2	82.6 ± 13.5	<0.001
SBP (mmHg)	112.6 ± 11.7	109.6 ± 9.7	113.2 ± 11.4	110.3 ± 12.2	0.264
DBP(mmHg)	66.8 ± 6.6	66.9 ± 7.6	67.1 ± 5.3	66.8 ± 5.9	0.06
SV (ml/min)	102.2 ± 23.1	99.9 ± 25.4	99.5 ± 35.5	86.8 ± 20.2[a]	<0.001
Q (L/min)	7.9 ± 2.5	8.1 ± 1.8	8.2 ± 2.7	7.1 ± 1.7[a]	0.002
SVR (Dyn.s/cm^5)	1176.5 ± 1785.7	1234.3 ± 2748.4	3009.4 ± 1243.9	1325.9 ± 1813.8	0.155

[r]epresents statistically significant from the other groups

DISCUSSION

The data suggest that wearing a mask during high-intensity exercise did not affect exercise hemodynamics. Additionally, wearing a mask during and post-exercise did not affect PEH. It does appear that wearing a mask may change the mechanisms of PEH. Indeed, despite no BP difference, Q was the lowest in the EXS-N95 group, while HR was the lowest in the CON-E group. The current study adds to our understanding of mask-wearing during exercise by suggesting that even during higher intensity exercise, mask-wearing does not alter the exercise response during and post-exercise.

CONCLUSION:

This study is consistent with current literature in suggesting that mask-wearing during exercise, even at high intensity, has no effect physiologically during exercise and on post-exercise hemodynamics.

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