ORIGINAL ARTICLE

The Use of Mask in Respiratory Exercise in the Era of COVID-19 Pandemic

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ABSTRACT

Introduction: The 2019 Coronavirus Disease (COVID-19) pandemic causes public health protocols to be strictly enforced. This may disrupt the willingness to practice sports and/or exercises due to the requirement of masks, which may be uncomfortable and limiting for some people. However, masks are not an obstacle for someone to exercise. Moreover, some exercises, including respiratory-focused ones, are known to be particularly beneficial for one's health. This study examined the effect of using masks on performing exercises, particularly respiratory exercises, in the era of COVID-19 pandemic.

Methods: A total of 24 people participated in this study using randomization and cross over techniques. The variables measured were respiratory rate, oxygen (O2) saturation, pulse rate, carbon monoxide (CO) levels, and fatigue scale using the Borg Breathless Score. Statistical test used independent t test, Wilcoxon, and Mann-Whitney U with a difference level of $p < 0.05$.

Results: There was no significant difference between the observed parameters (heart rate, respiratory rate, peripheral O2 saturation, CO levels, and Borg scale) in the groups using masks and not using masks.

Conclusion: The increase in pulse rate, respiratory rate, and Borg Scale in the aerobic phase of respiratory exercise is physiological and can improve significantly after the cooling phase.

INTRODUCTION

Since Coronavirus Disease 2019 (COVID-19) pandemic occurred, health protocols have been strictly enforced, such as regulations on social distancing and large-scale social restrictions, which certainly disrupt people's exercise habits. COVID-19 pandemic has also resulted in the closure of fitness centers, stadiums, swimming pools, dance studios, fitness centers, physiotherapy centers, parks, and playgrounds. As a result, many people are unable to exercise individually or in groups. In fact, they experience obstacles to do physical activities outside their homes.

Lack of access to regular exercise can lead to problems related to immune system and physical health, including exacerbating existing diseases in a lifestyle of minimal physical activity. In addition, lack of time for exercise and physical activity can also have an impact on mental health, hence people become stressed or experience anxiety because they are isolated from normal social life.

Regular exercise with respiratory muscle exercises can improve heart function, therefore blood flow throughout the body, especially to the respiratory muscles, becomes smooth. Smooth blood flow can increase the supply of nutrients to muscle cells, hence it will increase the intracellular calcium concentration. Calcium will stimulate action potentials and increase muscle cell contractility, especially respiratory muscle cells.[1,2]

With the global pandemic becoming more severe, Centers for Disease Control and Prevention (CDC) in United States recommended on 3 April 2020 that people wear a face mask in public if they cannot keep a distance

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of at least 6 feet from others to help prevent COVID-19 transmission. This suggestion for mask wear (and, in some cases, local and/or state-ordered mandates) appears to have sparked debate among the general population, particularly in United States. In addition, people in a variety of occupations who had never worn masks before were suddenly expected to do so. This includes, among other things, grocery shop and foodservice employees, bartenders, teachers, childcare providers, and laborers. This has raised a number of concerns, with masks being viewed as unpleasant, heavy, inconvenient, and obnoxious. It even raised concerns that wearing a mask for an extended period of time could be unhealthy or deadly.[3] This study examined the effect of using masks on respiratory exercises in the era of COVID-19 pandemic.

METHODS

This was quasi-experimental analytical study. This study was performed at Dr. Saiful Anwar General Hospital Malang on 6 and 20 March 2021 using primary data from the variables measured on the research subjects. It had been approved ethically by Dr. Saiful Anwar Hospital Health Research Ethics Commission with signed ethical approval number 400/082/K.3/302/2021.

The subjects were participants in respiratory exercise at Dr. Saiful Anwar General Hospital Malang who agreed to the informed consent and were divided into 2 groups for randomization. The subjects used were subjects who met the inclusion criteria of adults aged >18 years old and <40 years old, had no history of heart disease, were not in an exacerbation of asthma or other chronic diseases, did not smoke and drank alcohol at least 2 hours before exercise, did not fully eat at least 2 hours before exercise, had adequate rest at least 6 hours before exercise, and wore a standard 3 ply surgical mask. Meanwhile, the exclusion criteria were subjects who had comorbidities from screening and on preliminary examination the vital signs were unstable before giving exercise (breathing exercises). The subjects who failed the criteria were subjects with unstable hemodynamic during the implementation, fainting, and experienced chest pain or shortness of breath or coughing during breathing exercises. The respiratory exercise used in this study was developed by Indonesian Society of Respirology (ISR), known as ‘*senam Asma’* (asthma exercise), which did not necessarily mean that the exercise is indicated for asthmatics only, but also for healthy people and those with another respiratory disorders assessed by healthcare professionals. The exercise is mainly divided into 8 parts (warm-up, stretching, 2 parts of core movements, 3 parts of aerobics, and cooling down).

This study used cross over design technique. Subjects in group A took turns using masks in the first week and did not use masks the following week and group B who did not use masks in the first week took turns using masks the following week. Then each group was measured at the same place and at the same starting time, namely at 05.30 in the morning. Each group was measured for respiratory rate variables, oxygen (O_2) saturation using pulse oximetry, pulse rate, carbon monoxide (CO) levels using CO analyzer, and fatigue scale using the Borg Breathless Score.

Each variable was assessed in each group at the same time, e.g. before starting the breathing exercise, immediately after warming up, immediately after the core breathing exercise, immediately after the aerobic movement, immediately after the cooling down movement and 5 minutes after the cool-down or exercise, and when the breathing was completed.

The data obtained were recorded on the research sheet to be processed, analyzed and interpreted where the variable data with a normal distribution was assessed by unpaired T test and Mann-Whitney U test if the distribution was not normal. To analyze the relationship between numerical and categorical variables, it was performed with Pearson in SPSS version 26.

RESULTS

Demographic characteristics of the subjects which consisted of 24 participants can be seen in Table 1. The subjects of the study consisted of 2 active smokers and 22 non-smokers. Comorbidities were found in 2 subjects with controlled asthma and 4 subjects with allergic rhinitis

Table 1. Demographic characteristics of respiratory gymnastics participants

Parameter	Subjects (n = 24)
Sex	
Male	14 (58.33%)
Female	10 (41.67%)
Age (years old)	31.08 ± 2.96
Marital status	
Married	13 (54.17%)
Not married	11 (45.83%)
Weight (kg)	66.38 ± 11.62
Height (cm)	164.42 ± 8.50
BMI (kg/m^2)	24.48 ± 3.52
History of smoking	
Yes	2 (8.33%)
No	22 (91.67%)
Comorbidities	
Yes	6 (25%)
No	18 (75%)

Data is displayed as n (%) or mean (± SD). Abbreviation: BMI: Body Mass Index

Table 2. Comparison of examination parameters between the groups using masks and not using masks

Parameter	Mask (n = 24)	Non-mask (n = 24)	p-value
HR (x/minute)			
Before	86.45 ± 6.93	87.20 ± 7.42	0.687
Warm-up	100.71 ± 11.70	96.17 ± 11.45	0.152
Core movement	121.46 ± 16.88	119.83 ± 16.85	0.740
Aerobic	152.04 ± 12.74	150.83 ± 11.84	0.735
Cooling down	135.04 ± 12.53	131.83 ± 11.15	0.354
10 minutes after cooling down	121.46 ± 9.90	118.67 ± 9.86	0.333
RR (x/minute)			
Before	17.83 ± 1.37	17.58 ± 1.84	0.836
Warm-up	19.54 ± 1.89	19.17 ± 3.02	0.759
Core movement	22.54 ± 3.32	21.75 ± 2.56	0.631
Aerobic	29.79 ± 7.86	29.33 ± 4.72	0.716
Cooling down	24.54 ± 6.18	23.50 ± 4.05	0.670
10 minutes after cooling down	20.83 ± 3.25	20.50 ± 3.05	0.892
SpO_2(%)			
Before	98.33 ± 0.64	98.21 ± 0.66	0.522
Warm-up	98.04 ± 0.75	98.19 ± 0.74	0.697
Core movement	97.37 ± 1.41	97.58 ± 1.06	0.779
Aerobic	96.46 ± 1.28	96.88 ± 1.36	0.281
Cooling down	96.46 ± 1.74	96.75 ± 1.98	0.488
10 minutes after cooling down	97.38 ± 1.28	97.83 ± 1.20	0.141
CO level			
Before	2.08 ± 1.18	2.29 ± 1.99	0.966
Warm-up	1.92 ± 1.14	1.67 ± 1.76	0.250
Core movement	1.63 ± 1.13	1.75 ± 1.59	0.991
Aerobic	1.21 ± 0.83	1.25 ± 1.15	0.778
Cooling down	1.50 ± 0.78	1.54 ± 1.28	0.618
10 minutes after cooling down	1.46 ± 0.98	1.38 ± 1.01	0.533
Borg Scale			
Before	0.00 ± 0.00	0.00 ± 0.00	1.000
Warm-up	0.08 ± 0.28	0.08 ± 0.28	1.000
Core movement	1.46 ± 0.98	1.13 ± 0.90	0.236
Aerobic	4.17 ± 1.49	3.96 ± 1.52	0.580
Cooling down	2.17 ± 1.31	1.86 ± 1.36	0.332
10 minutes after cooling down	0.75 ± 0.94	0.71 ± 0.95	0.836

HR = heart rate; RR = respiratory rate; SpO_2 = peripheral oxygen saturation; CO = carbon monoxide. Statistical analysis used independent t-test or Mann-Whitney U test.

Table 3. Comparison of test parameters before and after aerobics

Parameter	Before aerobic	After aerobic	p-value
HR mask	86.45 ± 6.93	152.04 ± 12.74	<0.001
HR non-mask	87.20 ± 7.42	150.83 ± 11.84	<0.001
RR mask	17.83 ± 1.37	29.79 ± 7.86	<0.001
RR non-mask	17.58 ± 1.84	29.33 ± 4.72	<0.001
SpO_2 mask	98.33 ± 0.64	96.46 ± 1.28	<0.001
SpO_2 non-mask	98.21 ± 0.66	96.88 ± 1.36	<0.001
Borg Scale mask	0.00 ± 0.00	4.17 ± 1.49	<0.001
Borg Scale non-mask	0.00 ± 0.00	3.96 ± 1.52	<0.001

HR= heart rate; RR = respiratory rate; SpO_2 = peripheral oxygen saturation; CO = carbon monoxide. Statistical test used Wilcoxon with a significant level of $p < 0.05$

The comparison of examination parameters between the groups using masks and not using masks is shown in Table 2. The examinations assessed consisted of vital signs in the form of respiratory rate per minute, pulse per minute, peripheral O_2 saturation, CO levels, and fatigue levels measured by the Borg Scale. The results of this study showed that there was no significant difference in the parameters assessed between the groups using masks and not using masks.

Table 4. Comparison of test parameters after aerobics and after cooling down

Parameter	After aerobic	After cooling down	p-value
HR mask	152.04 ± 12.74	135.04 ± 12.53	<0.001
HR non-mask	150.83 ± 11.84	131.83 ± 11.15	<0.001
RR mask	29.79 ± 7.86	24.54 ± 6.18	<0.001
RR non-mask	29.33 ± 4.72	23.50 ± 4.05	<0.001
SpO_2 mask	96.46 ± 1.28	96.46 ± 1.74	<0.768
SpO_2 non-mask	96.88 ± 1.36	96.75 ± 1.98	<0.812
Borg Scale mask	4.17 ± 1.49	2.17 ± 1.31	<0.001
Borg Scale non-mask	3.96 ± 1.52	1.86 ± 1.36	<0.001

HR = heart rate; RR = respiratory rate; SpO_2 = peripheral oxygen saturation; CO = carbon monoxide. Statistical test used Wilcoxon with a significant level of $p < 0.05$.

Breathing exercises have several stages of movements from warming up to cooling down. From Table 3, it was found that both groups showed an increase in pulse per minute, respiratory rate per minute, peripheral O_2 saturation, and fatigue levels assessed from the Borg Scale before and after aerobic movement with a significance value of $p < 0.001$.

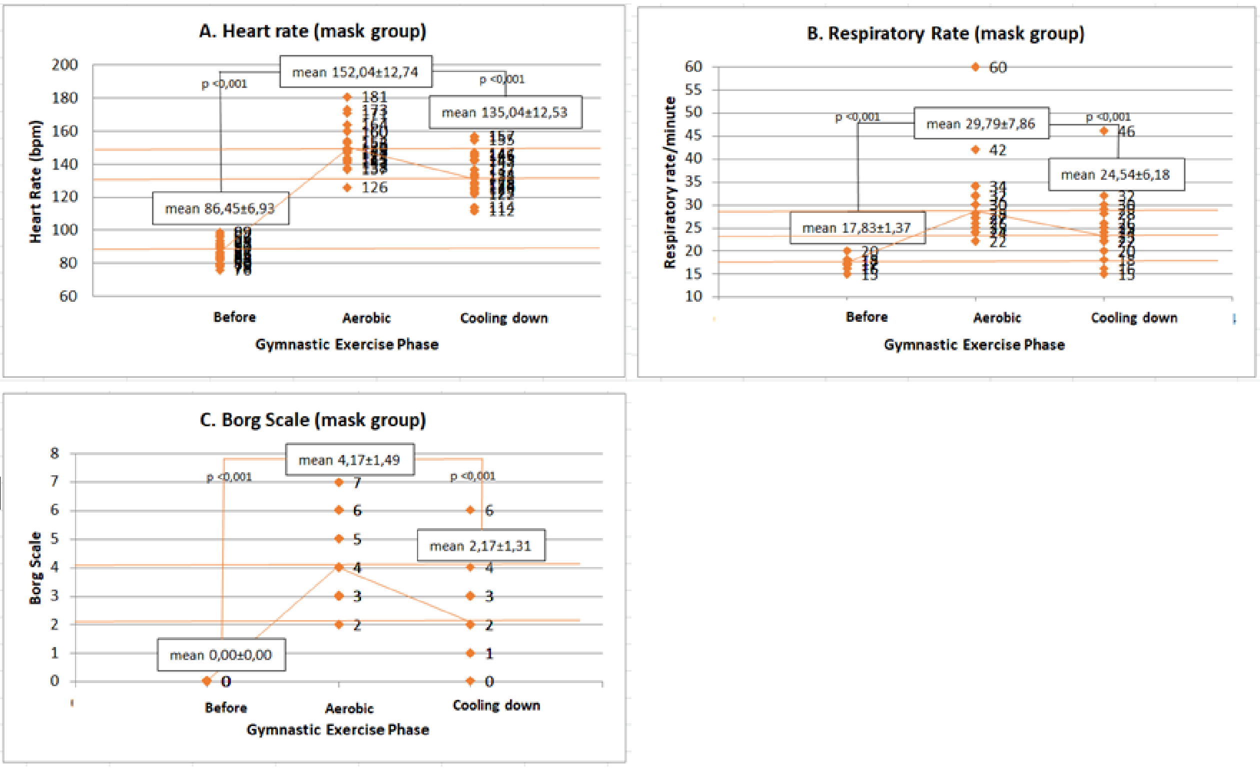

Figure 1A) Comparison of heart rate of respiratory exercise phase in the mask group. There were differences of heart rate in the mask group of the breathing exercise participants; **1B)** Comparison of respiration rate of respiratory exercise phase in the mask group. It can be seen that there were differences of respiration rate in the mask group of the breathing exercise participants; **1C)** Comparison of the Borg Scale of respiratory exercise in the mask group. The graphic image shows the difference in the Borg Scale in the mask group of the respiratory exercise participants.

Table 4 shows that after the cooling phase, there was a significant improvement in HR, RR, and fatigue levels assessed from the Borg Scale for both groups with $p < 0.001$ in each parameter.

Comparison of heart rate, respiratory exercise phase in the mask group shown in Figure 1A and 1B. The figure also provide the difference of the group with the Borg Scale diagram (Figure 1C).

DISCUSSION

During COVID-19 pandemic, we investigated the physiological changes related to the use of PPE and a N95 respirator among frontline healthcare workers. To protect healthcare workers against the new COVID-19 pandemic, PPE with respiratory protective equipment is required. However, this protection does not come without some physiological drawbacks.

Some study found that the use of these masks may alter some of body physiology parameters[4] while some do not,[5] even though most of existing studies agrees that there are, more or less, some observed difference in these parameters aside from subjective discomfort and another subjective complaint of the subjects. Many factors are thought to contribute to these discrepancies. The effect of microenvironment, such as high temperatures and humidity levels, may have resulted in a high microenvironment temperature and humidity inside the masks. This may cause a higher resistance to breathing through the mask, and, as a result, a drop in O_2 saturation after donning, which, while statistically significant, does not appear to be clinically significant.[4] Aside from humidity, temperature, mask type, and exercise intensity, all appears to influence the effects of a mask during exercise and should be considered when deciding whether to wear one or not. There are no studies which examine O_2 saturation or partial pressure of O_2 in response to exercise with a mask so far. We would assume that, while O_2 and carbon dioxide (CO_2)concentrations in the blood would remain relatively steady at these high exercise intensities, there would be pain due to the mask's increased skin warmth and breathing resistance.[3]

A new study comparing the effects of wearing a surgical vs. N95 face mask on cardiopulmonary exercise capacity in 12 healthy males backs up this conclusion. The use of either mask significantly impaired pulmonary function and ventilation during an ergometer incremental exertion test (i.e. a high-intensity test until exhaustion). Mask wear lowered cardiopulmonary exercise capacity (lower peak blood lactate response) and people experienced discomfort while wearing the mask, particularly the N95. It is worth noting, though, that these studies focused on really high-intensity exercise, which is likely more intense than the ordinary workout for most people. If discomfort persists, exercisers may need to either persevere through the discomfort or reduce their exercise intensity while wearing a mask. Additionally, wearing looser fabric masks made of moisture-wicking materials could improve comfort when exercising.[3]

In this study, we found no significant difference between the observed parameters (heart rate, respiratory rate, peripheral O_2 saturation, CO levels, and Borg scale) in the groups using masks and not using masks while doing breathing exercises. These results were consistently obtained in all phases of respiratory exercise starting from warming up, core movements, aerobic movements, and cooling down. These results are in accordance with the hypothesis of this study. The results of this study indicate that masks, both cloth masks and surgical masks, can be used safely when performing sport activities in general, and especially breathing exercises, without a significant effect on performance and body physiology.

When it comes to N95 filtering facepiece respirator (FFR) tolerance, comfort is crucial. With the usage of N95 respirator and PPE, the participants' self-perceived pain increased over time. While this result is not surprising, we measured it using a modified Borg dyspnoea scale. The post-doffing scores were significantly higher, implying that PPE and FFRs placed an additional load on healthcare workers while working in the ICU for an extended period of time, making their working environment more stressful. Furthermore, after 4 hours of wearing N95 as well as post-doffing, the level of exertion required to accomplish the work increased dramatically, resulting in increased fatigability and discomfort.[4]

The results of this study are also in line with several other studies which obtained similar results. Shaw, *et al*. stated that the use of masks did not significantly affect the spread of infectious droplets and also did not affect performance and other physiological parameters.[6] Lassing, *et al*. also revealed that, even though face mask use increased airway resistance and heart rate during exercises in healthy individuals, there was no change in performance and perceived exertion,[7] this is similar to the study conducted by Hopkins, *et al*.[8] However, special attention should be implemented for specific populations, such as with severe cardiopulmonary diseases,[8] underlying lung disorders, and those with pre-existing lung diseases[9,10] in which exercise performance and capacity may be impaired.[8]

Though PPE is critical for safeguarding healthcare workers in a physically demanding setting where there is a higher chance of infection with COVID-19, it also has a negative impact that must be considered. The well-being of healthcare workers is critical for effective pandemic control. As a result, institutional policies should be designed to guarantee that employees are given frequent breaks during long hours, receive appropriate water and nourishment, remove PPE safely, and report symptoms connected to their PPE. Research regarding more comfortable protective gear, as well as better engineering improvements to work spaces, such as negative pressure environments with correct temperature and humidity monitoring, should be promoted.[4]

The limitations of this study were the small and relatively homogeneous sample size. In the future, similar research is needed with a larger sample size and includes subjects with a wider range of characteristics, for example in patients with chronic lung disease.

LIMITATIONS

This study has several limitations. First, the samples and the narrow age ranges of the samples may not reflect general population. Second, the clinical characteristics of the samples may not reflect general community. Third, the study did not measure serum levels of lactic acid which had been widely used as the indicator of exercise intensity.

CONCLUSION

There was no significant difference in the parameters of pulse per minute, respiratory rate per minute, peripheral O_2 saturation, CO levels, and fatigue levels assessed from the Borg Scale in the groups using masks and not using masks. The increase in pulse rate, respiratory rate and Borg Scale in the aerobic phase of respiratory exercise is physiological and can improve significantly after the cooling phase. Exercise using mask in the era of COVID-19 pandemic has no significant effect compared to non-mask exercise in the context of vital signs, CO levels, and Borg scale. Therefore, we suggest it may be beneficial for people to keep exercising wearing a mask in the era of COVID-19 pandemic.

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Conflict of Interest
The author stated there is no conflict of interest in this study.

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Authors' Contributions
Data sampling, analysis, and discussion: SD, ASL, LTH, AC, SAF, AY. All authors have read and agreed to the final version of the manuscript.

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