ORIGINAL ARTICLE

Physical Therapy Journal of Indonesia (*PTJI*) 2024, Volume 5, Number 2: 146-150
E-ISSN : 2722-6034 ; P-ISSN : 2722-0125

Comparison of cardiorespiratory fitness levels between wearing and not wearing masks in physiotherapy students

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Received: 2024-03-08
Accepted: 2024-06-12
Published: 2024-07-15

ABSTRACT

Background: Masks, devices used to cover the face, nose, and mouth area to prevent the transmission of viruses, bacteria, diseases, and air pollution, have become a topic of pros and cons among the public regarding their impact on cardiorespiratory fitness during physical activity, as some claim that masks decrease airflow to the lungs thus reducing oxygen in the blood and muscles which makes activity more difficult, while other studies have shown no difference in cardiorespiratory fitness values with or without masks. The purpose of this study was to determine the difference in cardiorespiratory fitness levels when wearing a mask and not wearing a mask in physiotherapy students.

Methods: This study used an analytical observational design with a one-group pre-post test design and a consecutive sampling technique involving 35 physiotherapy students from the Faculty of Medicine, Universitas Udayana. This research was conducted at the Physiotherapy Building, Faculty of Medicine, Universitas Udayana, in June 2023. The inclusion criteria included physiotherapy students aged ≥ 18 with normal vital signs who used a 3-ply surgical mask. The exclusion criteria were students with a history of respiratory problems and those who did not use a 3-ply surgical mask. Cardiorespiratory fitness was measured using the Harvard step test.

Results: This study showed that the research subjects were dominated by students with poor cardiorespiratory fitness when wearing a mask or not wearing a mask, namely 35 students (100%).

Conclusion: There was no significant difference in cardiorespiratory fitness levels between mask wearers and non-wearers, with a *p*-value of 0.180 (>0.05).

Keywords: cardiorespiratory, fitness, university students, mask use.
Cite This Article: Adiniti, N.M.W.H., Antari, N.K.A.J., Tianing, N.W., Nugraha, M.H.S. 2024. Comparison of cardiorespiratory fitness levels between wearing and not wearing masks in physiotherapy students. *Physical Therapy Journal of Indonesia* 5(2): 146-150. DOI: 10.51559/ptji.v5i2.212

INTRODUCTION

Coronavirus disease 2019 (COVID-19) first appeared in Wuhan, China, in late 2019 and then spread to Indonesia in March 2020. Covid-19 is a virus that attacks breathing.[1] The government has implemented a policy of wearing masks and other measures such as hand washing, distancing, and other preventive measures to prevent the spread of Covid-19. A mask is a device used to cover the mouth and nose, helping to limit the spread of viruses, including Covid-19.[2] WHO recommends several types of masks to prevent the transmission of this virus, including cloth masks, 3-ply surgical masks, N95 masks, and reusable facepiece respirators.[3]

Students have a low risk of contracting COVID-19 but can have a high potential as carriers who transmit the virus to people around them.[4] Due to the awareness of the importance of maintaining health, especially given the age that tends to be more mature and a better understanding of health protocols during a pandemic, students tend to be more compliant in wearing masks.[5]

Cardiorespiratory fitness is the body's ability to deliver oxygen to the muscles during moderate to vigorous activity without feeling tired and still have stamina for other activities. Cardiorespiratory fitness is an important part of basic fitness and can indicate how healthy and active a person's lifestyle is. Cardiorespiratory endurance level can also indicate the maximum oxygen volume the body can handle.[6]

Factors affecting cardiorespiratory fitness include age, gender, physical activity level, genetics, and body mass index (BMI). If cardiorespiratory fitness is poor, it can affect health, productivity, and learning outcomes. Someone with good cardiorespiratory fitness is more productive.[7] Research by Rikawiantari *et al.* (2021) on physiotherapy students at Universitas Udayana shows that most students have a low cardiorespiratory endurance level.[8]

Wearing a mask can reduce airflow to the lungs, so less oxygen enters the body. This can make it harder for a person to move, slower, and more tired.[9] The use of masks can reduce cardiorespiratory fitness levels, such as a decrease in VO2max by 13% to 29%.[10,11] Cardiorespiratory fitness is important because it can help a person

be more productive in learning, including students who can concentrate longer while attending lectures.[12] Students with low cardiorespiratory fitness may find it difficult to participate in lectures, which could affect their learning outcomes.[7]

Based on previous studies, wearing a mask is safe for healthy people, and no adverse effects have been reported in terms of heart health or general after tests.[13] However, some people complain that wearing a mask during activities can make them feel tired more quickly. Therefore, the researcher decided to conduct a study on the comparison of cardiorespiratory fitness levels when wearing a mask and not wearing a mask in Physiotherapy Students. This research is important because of the lack of research on cardiorespiratory fitness when wearing masks in Bali and the absence of data on the level of cardiorespiratory fitness in physiotherapy students, especially at Universitas Udayana. Thus, this study is an important basis for further understanding the use of masks in the future.

METHODS

This research design was an observational analytic study with one group pre- and post-test design. This research was conducted at the Physiotherapy Building, Faculty of Medicine, Universitas Udayana, in June 2023. The independent variable in this study is the use of masks, and the dependent variable is the level of cardiorespiratory fitness. The control variables in this study were age and type of mask.

The sample inclusion criteria in this study were physiotherapy students aged ≥ 18 years, normal vital sign measurement values, students who used masks with 3-ply surgical masks and were willing to participate by agreeing to informed consent. The sample exclusion criteria in this study were students with a history of respiratory problems and students who did not use 3-ply surgical masks. The Harvard step test was used to measure the level of cardiorespiratory fitness. The global physical activity questionnaire (GPAQ) was used to measure students' physical activity levels.

A sample of 35 students was obtained using a *consecutive sampling* technique. This study has three data analyses: univariate analysis, normality test analysis, and bivariate analysis. Univariate analysis will describe the distribution of characteristics of age, gender, BMI, physical activity, mask use, and cardiorespiratory fitness level. Normality test analysis describes the data distribution in this study using Shapiro-Wilk because the sample size is below 50 people. Due to the normal distribution of data, the bivariate analysis used the Paired Sample t-test comparison test to determine the comparison of cardiorespiratory fitness when wearing a mask and not wearing a mask.[14] The Ethics Commission of the College of Medicine, Universitas Udayana, approved the research with approval number 1118/UN14.2.2.VII.14/LT/2023 after a thorough evaluation. All participants willingly consented to join the study and signed an informed consent document, acknowledging their understanding of the research's objectives, methods, and potential risks.

RESULTS

The characteristics of the 35 research samples obtained in this study include age, gender, BMI, physical activity, cardiorespiratory fitness when wearing a mask, and cardiorespiratory fitness when not wearing a mask. After univariate analysis, the frequency distribution data and percentage of the characteristics of the research sample can be seen in Table 1.

Table 1 shows that based on age, the age range of students who fit the inclusion criteria is 19-23 years, with the largest sample being 21 years (40.0%). Based on gender, it can be seen that it is also dominated by female samples, with 31 people (88.6%) and four men (11.4%). Based on BMI, the dominant sample was at a normal BMI of 19 people (54.3%). Based on the level of physical activity, it was found that out of 35 samples, there were 28 people (77.8%) with moderate physical activity levels, five people with light physical activity (13.9%), and two people (5.6%) with high physical activity levels. When based on the distribution of cardiorespiratory fitness conducted with the Harvard step test and carried out twice on different days between wearing a mask and not wearing a mask, the results showed that all samples in the study fell into the poor category, both when wearing a mask and not wearing a mask. The poor category in the interpretation of fitness is different

Table 1. Frequency distribution of student characteristics

Student characteristics	(n)	(%)
Age		
19	1	2.9
20	12	34.3
21	14	40.0
22	7	20.0
23	1	2.9
Gender		
Male	4	11.4
Women	31	88.6
BMI		
Underweight	7	20.0
Normal	19	54.3
Overweight	5	14.3
Obesity	4	11.4
Physical activity (GPAQ)		
Lightweight	5	13.9
Medium	28	77.8
Weight	2	5.6
Cardiorespiratory fitness while wearing a mask		
poor	35	100.0
Cardiorespiratory fitness while not wearing a mask		
Poor	35	100.0

%, percentage; BMI, body mass index; GPAQ, global physical activity questionnaire; n, frequency

Table 2. Paired sample t-test results between cardiorespiratory fitness when wearing and not wearing a mask

Description	n	*P*-value
Cardiorespiratory fitness when wearing a mask - cardiorespiratory fitness when not wearing a mask	35	0.180

n, frequency

between men and women. The poor category in men is <55 while in women <50. The average value of cardiorespiratory fitness when wearing a mask is lower than without a mask. However, the difference obtained is relatively low and still in the same category, namely the poor category. The average duration of mask use is 4.04 hours per day, with a maximum duration of 2 hours in one use.

Table 2 shows the results of the *Paired sample t-test* with a significance value where the p-value = 0.180 (p>0.05). If the p>0.05 value can be stated, there is no significant difference between cardiorespiratory fitness when and when not. This shows no significant effect on the difference in treatment given to each variable.

DISCUSSIONS

After the paired sample *t-test* comparison test showed the results, there was no significant difference between cardiorespiratory fitness when wearing a mask and not wearing a mask on physiotherapy students, with a *p-value* of 0.180 (p>0.05).

The results of this study are not in line with the research of Fikenzer et al. (2021) and Driver et al. (2020), which showed that the use of masks could reduce VO2max values.[10,11] Pulmonary function parameters were measured with an additional spirometry mask over the face mask, which increased physiological demands.[15] However, wearing this spirometry mask has limitations in generalization as it alters the leakage characteristics commonly used, and the additional pressure exerted by the spirometry mask can affect respiratory resistance and airflow.[16] This study only used 3-ply surgical masks without additional spirometry masks. Research by Sagita *et al.* (2023) using the same measuring instrument found no significant difference in fitness values between a mask and not a mask.[17] Lack of physical activity can decrease muscle strength and fatigue.[6] This study also found that some samples had higher cardiorespiratory fitness values when wearing a mask, while others had higher values when not. Although the statistical difference was relatively low, it fell into the poor category.[6]

Poor cardiorespiratory fitness is influenced by various factors such as genetics, physical activity, and gender. As described by Damayanti (2019), physical activity can reduce the heart muscle's strength, impair the heart's pumping function, and disrupt the body's homeostasis.[18] Light to moderate physical activity levels can increase heart rate, while high activity levels reduce the risk.[19]

Light to moderate physical activity showed no significant difference in cardiorespiratory fitness levels between masked and unmasked individuals. In individuals with mild to moderate physical activity, increased respiratory frequency may reduce the amount of air reaching the alveoli for oxygen diffusion.[20] Lack of physical activity can also affect the body's intake, capacity, and oxygen utilization, leading to low cardiorespiratory fitness.[21] Other factors that could affect cardiorespiratory fitness, such as body adaptation, the intensity and type of physical activity performed with a mask, and the individual's health condition, also need to be considered.

The body's adaptation to breathing patterns when regularly wearing a mask may take several weeks. This adaptation varies between individuals and cannot be ascertained with certainty as it depends on the intensity of the physical activity. In light to moderate activities while wearing a mask, adaptation of breathing patterns may occur more quickly, while in more strenuous activities that require more oxygen, adaptation takes longer.[22]

Adjustment of breathing pattern is a complex physiological response controlled by the brain and autonomic nervous system to ensure adequate oxygen supply and removal of excessive carbon dioxide. This adjustment mechanism involves various factors, including central and peripheral chemoreceptors and mechanoreceptors in the lungs, which relay sensory information to the brain to regulate respiratory drive.[23] This adaptation process varies between individuals and is influenced by the intensity of physical activity performed. While some people may initially experience breathing difficulties when wearing a mask during physical activity, the body adapts to a more efficient breathing pattern to overcome these obstacles over time. This adaptation allows individuals to remain comfortable performing physical activities even with a mask.[24] Therefore, it can be concluded that respiratory adaptation takes time to adapt to a mask.

Bodily adaptation refers to a person's physiological ability to change and adjust to a particular stimulus or condition.[25] Some adaptations to mask use include increased breathing capacity, improved cardiac and vascular performance, and decreased perception of discomfort. The body can increase breathing capacity by increasing breathing efficiency in response to mask use. This can help reduce the burden on the respiratory system. In addition, the heart strives to pump more blood throughout the body, while blood vessels may undergo expansion to increase blood flow. Although initially wearing a mask during physical activity may cause discomfort, the body can physiologically adjust and reduce the perception of discomfort, making breathing patterns more efficient.[24]

High-intensity activities, such as high-interval training, may affect cardiorespiratory performance and fitness more than light or moderate activities due to increased oxygen demand. The type of mask used in this study was a 3-ply surgical mask, which WHO recommends for the general public. Several studies have shown that wearing surgical masks during light to moderate physical activity has no significant effect on cardiorespiratory fitness. Research by Steinhiber et al. (2023) found that wearing a surgical mask did not increase overall heart rate compared to no mask and did not cause adverse side effects in physical labor. Although some individuals showed increased fitness

scores, these results were not statistically significant. Individual health conditions, including respiratory issues, may affect how an individual responds to mask use during physical activity.[26]

Compensatory mechanisms and bodily adaptations function differently between healthy individuals and those with chronic diseases.[27] Research by Steinhiber et al. (2023) found that in healthy individuals, the body's physiology may not be clinically affected by wearing a mask for longer periods. In this study, the sample was in good health and had no respiratory problems, allowing the body to adapt to wearing a mask by regulating breathing patterns to ensure adequate oxygen supply.[26]

This study has several shortcomings, such as the use of masks not being mandatory and only being used for a short duration in the post-COVID-19 transition period. The physical activity of the subjects was not controlled and was generally at a light to moderate level, so the effect of mask use was not very pronounced. In addition, the subjects were not controlled, so the results of the study combining various BMI categories showed no difference in cardiorespiratory fitness when wearing a mask and not wearing a mask. However, analyses per BMI category may have yielded different results. Most subjects had a normal BMI, so the effect of wearing a mask on cardiorespiratory fitness was insignificant compared to subjects who had an under or over BMI. The lack of subjects caused the data to be less varied, and no fatigue test was performed before the Harvard step test measurement to ensure the sample was not in a state of fatigue.

CONCLUSION

Based on research and test analysis, it can be concluded that there was no difference in the level of cardiorespiratory fitness between wearing and not wearing masks among Physiotherapy Students of College of Medicine, Universitas Udayana.

ETHICAL CLEARANCE

The Research Ethics Commission of the College of Medicine, Universitas Udayana, approved the study under number 1118/UN14.2.2.VII.14/LT/2023. Respondents gave informed consent, allowing the use of sampling.

CONFLICT OF INTEREST

This study did not report conflicts of interest. The researchers ensured that no financial, personal, or professional influences could have affected the study's outcomes or interpretations.

FUNDING

No grants or financial support from any institution were provided for this study, which the researchers conducted without any external funding sources.

AUTHOR CONTRIBUTIONS

NMWHA designed the study, collected and processed the data, and wrote the manuscripts. NKAJA, NWT, and MHSN supervised data collection and revised the manuscript.

ACKNOWLEDGEMENT

The authors thank all parties involved in this study.

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