

# Impacts of surgical mask wearing on cardiopulmonary fitness using a six-minute walk test among older adults with hypertension

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**Background:** This study aims to investigate the impacts of surgical mask wearing on cardiopulmonary fitness using a six-minute walk test (6MWT) among older adults with hypertension.

**Methods:** The 45 older adults with hypertension volunteers were recruited and randomized into a no mask wearing condition and a surgical mask wearing condition. All volunteers were investigated through submaximal exercise testing using a 6MWT. Cardiopulmonary parameters were measured before and after performing a 6MWT.

**Results:** The results indicate post performance on the 6MWT for both the with and without surgical mask conditions significantly increased systolic blood pressure, heart rate, respiratory rate, and oxygen saturation (SpO<sub>2</sub>) when compared to before performing a 6MWT. However, surgical masks resulted in no differences to systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate, SpO<sub>2</sub>, and 6MWT distance when compared to no masks. In contrast, the surgical mask condition significantly increased perceived exertion when compared with the no mask condition ( $p < 0.05$ ).

**Conclusion:** This study indicates that surgical masks did not have an impact on cardiopulmonary fitness in older adults with hypertension.

**Key Words:** surgical mask; six-minute walk test; cardiopulmonary fitness; older adults; hypertension

## INTRODUCTION

The risk of coronavirus disease 2019 (COVID-19) in older adults is increasing at present, with underlying diseases and immune systems that stimulate viral-activated cytokine storms resulting in respiratory system failure [1]. The risk of COVID-19 death is higher among older adults than among the young [2]. It is therefore crucial to protect older adults from COVID-19. Mask wearing is commonly recommended to prevent the spread of exhaled respiratory droplets and mitigate person-to-person transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [3, 4]. Several types of masks are currently available and are selected according to personal preference [5]. Everyone is required to wear surgical masks to prevent COVID-19 [6]. However, masks can have issues for the wearer during vigorous physical activities, including being uncomfortable, impairment of gas exchange, and increased breathing difficulties [7–9].

Several studies have reported that masks increased respiratory resistance and discomfort among healthy volunteers [7, 10]. It is known that individuals with hypertension showed impaired gas exchange and heart dysfunction [11]. Nonetheless, little is known about the effect of mask wearing on cardiorespiratory fitness in this population. Only a single study has evaluated the effects of masks on the rating of perceived exertion (RPE), oxygen saturation (SpO<sub>2</sub>), and six-minute walk test (6MWT) distance among pulmonary arterial hypertension (PAH) patients [12]. The study found that masks had no discernible impact on the RPE, SpO<sub>2</sub>, and 6MWT in PAH patients [12]. Interestingly, hypertension is

the most common disease found in older adults [13, 14]. One study investigated the effects of mask wearing on SpO<sub>2</sub> among older adults, which found that older adults wearing a non-medical mask experienced no change to SpO<sub>2</sub> compared to individuals who did not wear masks [15]. Nonetheless, the impacts of surgical masks on cardiopulmonary fitness among older adults with hypertension have not been reported. Therefore, this study aims to assess the impacts of surgical masks on blood pressure, heart rate, respiratory rate, pulse SpO<sub>2</sub>, and perceived exertion before and after performing a 6MWT and the 6MWT distance in older adults with hypertension.

## MATERIAL AND METHODS

This study was approved by the Clinical Research Ethics Committee of the University of Phayao, Phayao, Thailand (1.1/011/65).

### Study design

A randomized crossover trial was used to investigate the impacts of wearing surgical masks on blood pressure, heart rate, respiratory rate, pulse SpO<sub>2</sub>, and perceived exertion before and after performing the 6MWT in older adults with hypertension.

### Participants

The 45 older adults with hypertension were screened by doctors and voluntarily participated in this study. The sample size was calculated using a

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power of 0.95, power analysis with an effect size of 0.55, and alpha of 0.05 [16]. Subjects who were 65 years old with hypertension and able to walk for six min without assistive walking devices were recruited. The exclusion criteria were subjects who had serious medical problems that could affect 6MWT performance such as standing or walking impairments, balance impairment, or unstable cardiorespiratory diseases.

**Procedure**

Older adults with hypertension were evaluated using baseline demographic data including height, weight, body mass index (BMI), blood pressure, heart rate, respiratory rate, and pulse SpO<sub>2</sub>. This study was performed following a CONSORT 2010 statement [17]. Each subject performed two protocols including the 6MWT while not wearing a mask and again while wearing a surgical mask. Test sequences were randomly assigned using the website randomizer.org. Cardiopulmonary parameters were measured pre and post protocol, while the distance covered during the 6MWT was assessed at the end of each test.

The surgical masks used were standard three-ply disposable face-masks (SKIN US LOC Co., Ltd.). Subjects wore the same surgical masks before and after performing the 6MWT.

In the 6MWT protocol, each older adult with hypertension was asked to wear comfortable clothing and shoes. Before the test, each subject was instructed not to wear a mask and sit on a chair with normal breathing for 30 min. Each subject performed a 6MWT according to the group to which they had been assigned. The first investigator encouraged the subjects to walk as fast as possible without running for the duration of the 6MWT, continuing at the same pace without stopping. The distance completed in each 6MWT was recorded [18]. After completing the 6MWT, the subjects were instructed to wear their masks and proceed to the assessment area. The second investigator did not know to which group the subjects had been assigned to and had no entry to the registration number or the area of the 6MWT. Cardiopulmonary parameters were assessed pre and post 6MWT. Sixty minutes of rest were allocated between each 6MWT to minimize fatigue [18]. The flow diagram of the subjects through each stage of this study is shown in Figure 1.

**Statistical analysis**

Descriptive statistics was used to analyze demographic data. A paired t test was used to compare cardiopulmonary parameters, including blood pressure, heart rate, respiratory rate, pulse SpO<sub>2</sub>, and perceived exertion, pre and post performing a 6MWT and to compare cardiopulmonary

parameters and walking distance during a 6MWT between the no mask condition and the surgical mask condition. IBM SPSS Statistics software, version 22.0 (IBM Corp., Armonk, NY, USA) was used in this study, with a P value of less than 0.05 set to denote significance.

**RESULTS**

Table 1 presents the volunteer characteristics. The older adults with hypertension had normal levels of BMI, diastolic blood pressure, heart rate, respiratory rate, and SpO<sub>2</sub>. While, subjects had a high level of systolic blood pressure, with results presented in Table 1.

All subjects performed a 6MWT without wearing a mask. After performing the 6MWT they had significantly increased systolic blood pressure, heart rate, respiratory rate, and SpO<sub>2</sub> when compared to before performing the 6MWT. No difference in diastolic blood pressure was recorded before and after performing the 6MWT (Table 2).

All subjects performed the 6MWT while wearing surgical masks. Systolic blood pressure, heart rate, respiratory rate, and SpO<sub>2</sub> were significantly increased after performing the 6MWT while wearing surgical masks when compared to before performing the 6MWT while wearing surgical mask. Diastolic blood pressure did not change before and after performing a 6MWT while wearing surgical masks (Table 3).

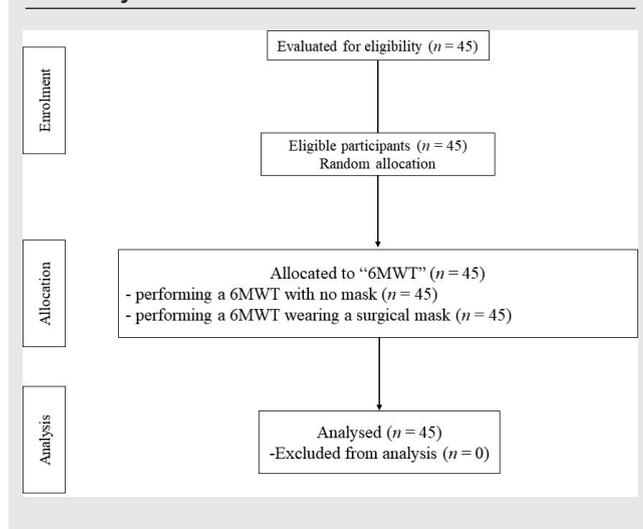
After performing a 6MWT while not wearing masks and a 6MWT while wearing surgical masks, there were no differences in systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate, SpO<sub>2</sub>, and 6MWT distance. Performing a 6MWT while wearing surgical masks significantly increased the RPE score after the test, as indicated by perceived exertion compared to while not wearing masks (*p* < 0.05) (Table 4).

**DISCUSSION**

This study indicates that wearing and not wearing a surgical mask affected volunteers' cardiopulmonary parameters, including systolic blood pressure, heart rate, respiratory rate, and SpO<sub>2</sub>, after performing a 6MWT. In addition, surgical masks resulted in no differences to systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate, SpO<sub>2</sub>, and 6MWT distance except for perceived exertion when compared to no masks.

Our results find that systolic blood pressure, heart rate, and respiratory rate were increased and SpO<sub>2</sub> was decreased post performing a 6MWT in older adults with hypertension without masks and while wearing surgical masks. These responses occurred due to the prolonged inspiratory activity that induces high negative intrathoracic pressure, resulting in elevated cardiac preload, systolic volume, and cardiac afterload, respectively. These changes increase systolic blood pressure, heart rate, and respiratory rate. In addition, the decreased oxygen levels in the blood resulted in reduced SpO<sub>2</sub> [19, 20]. These findings consisted of a previous study showing that older adults while wearing and not wearing

**FIGURE 1**  
The flow diagram of the subjects through each stage of this study. 6MWT = six-minute walk test.



**TABLE 1**  
Characteristics of the older adults with hypertension

Variables	n = 45 (F = 34, M = 11)
Sex, n (%)	
Males	11 (24.44)
Female	34 (75.56)
Age, years	69.42 ± 3.88
Weight, kg	50.64 ± 5.31
Height, cm	154.56 ± 7.90
BMI, kg/m <sup>2</sup>	21.17 ± 1.21
Systolic blood pressure, mmHg	146.28 ± 9.74
Diastolic blood pressure, mmHg	75.13 ± 7.08
Heart rate, bpm	78.91 ± 10.11
Respiratory rate, breaths per min	16.71 ± 1.55
SpO <sub>2</sub> , %	97.78 ± 1.38

Note: Values are means ± SD. n = number, F = female, M = male, kg = kilograms, cm = centimetres, BMI = body mass index, bpm = beats per min, SpO<sub>2</sub> = pulse oxygen saturation, % = percentage.

**TABLE 2**  
**Impacts of no mask on cardiopulmonary parameters among older adults with hypertension**

Variables	Pre 6MWT	Post 6MWT	P value
Systolic blood pressure, mmHg	140.35 ± 4.81	147.09 ± 5.23	<0.01
Diastolic blood pressure, mmHg	79.49 ± 8.16	80.42 ± 8.75	0.57
Heart rate, bpm	80.31 ± 10.14	84.47 ± 10.71	<0.01
Respiratory rate, breaths per min	17.62 ± 1.61	23.33 ± 2.92	<0.01
SpO <sub>2</sub> , %	98.13 ± 0.81	97.89 ± 1.03	<0.01

Note: 6MWT = six-minute walk test, bpm = beats per min, SpO<sub>2</sub> = pulse oxygen saturation, % = percentage.

**TABLE 3**  
**Impacts of surgical mask on cardiopulmonary parameters among older adults with hypertension**

Variables	Pre 6MWT	Post 6MWT	P value
Systolic blood pressure, mmHg	141.31 ± 3.43	147.67 ± 4.85	<0.01
Diastolic blood pressure, mmHg	80.33 ± 8.19	80.80 ± 7.93	0.11
Heart rate, bpm	81.24 ± 8.59	85.42 ± 9.30	<0.01
Respiratory rate, breaths per min	17.04 ± 12.09	23.73 ± 2.61	<0.01
SpO <sub>2</sub> , %	98.51 ± 0.59	97.91 ± 1.00	<0.01

Note: 6MWT = six-minute walk test, bpm = beats per min, SpO<sub>2</sub> = pulse oxygen saturation, % = percentage.

**TABLE 4**  
**The comparison between no mask and surgical mask conditions on cardiopulmonary parameters among older adults with hypertension**

Variables	No mask	Surgical mask	P value
Systolic blood pressure, mmHg	147.09 ± 5.23	147.67 ± 4.85	0.65
Diastolic blood pressure, mmHg	80.42 ± 8.75	80.80 ± 7.93	0.64
Heart rate, bpm	84.47 ± 10.71	85.42 ± 9.30	0.45
Respiratory rate, breaths per min	23.33 ± 2.92	23.73 ± 2.61	0.22
SpO <sub>2</sub> , %	97.89 ± 1.03	97.91 ± 1.00	0.67
RPE	7.47 ± 0.59	8.84 ± 0.90	0.03
Distance of 6MWT, m	409.11 ± 22.14	408.62 ± 22.50	0.84

Note: bpm = beats per min, SpO<sub>2</sub> = pulse oxygen saturation, % = percentage, RPE = rate of perceived exertion, 6MWT = six-minute walk test, m = metre.

masks exhibited slightly increased blood pressure, heart rate, and respiratory rate after performing a 6MWT [21]. Furthermore, this study showed that wearing surgical masks slightly increased the respiratory rate and decreased SpO<sub>2</sub> when compared to no masks after performing the 6MWT. However, there was no statistically significant difference between conditions. Additionally, our results found that perceived exertion statistically significantly increased in those wearing surgical masks compared to no masks. This change occurred because masks induced airflow resistance, increased facial temperature, and trapped heat or moisture from inhaled air, leading to increased dyspnea [22–24]. Previous studies found that 6MWT distances in healthy participants with masks were similar with those with no masks [16, 25]. In contrast, the changes after a 6MWT were found in patients with chronic lung disease or heart failure [26, 27]. Our study involved no volunteers with heart failure or chronic lung disease, although one individual with hypertension had breathlessness and pulmonary gas exchange impairment, resulting in arterial hypoxemia during exercise [11, 28]. However, our study found that SpO<sub>2</sub> was not statistically significantly different between hypertension without masks and when wearing masks. Therefore, these findings suggest that surgical masks are safe and have no harmful impact on exercise capacity among older adults with hypertension.

#### LIMITATION OF THIS STUDY

Our study may be limited by sample size. It is possible that some variables might reach statistical significance with a more suitable sample size.

#### CONCLUSION

Surgical masks are found to have no impact on systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate, SpO<sub>2</sub>, and 6MWT

distance except for perceived exertion after performing a 6MWT among older adults with hypertension.

#### DISCLOSURES

##### Contributors

All authors contributed to the conception or design of the work and the acquisition, analysis, or interpretation of the data. All authors were involved in drafting and commenting on the paper and have approved the final version.

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##### Competing interests

The authors completed the ICMJE uniform disclosure form and declare no conflict of interest.

##### Ethical approval

This study was approved by the Clinical Research Ethics Committee of the University of Phayao, Phayao, Thailand (1.1/011/65).

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