ORIGINAL ARTICLE

Comparison of Physiological Effects of Using Face Mask and Personal Protective Equipment (PPE) during Six-Minute Walk Test among Healthy Adults – A Pilot Study.

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Abstract

Introduction: Since the beginning of COVID-19, speculation surrounding the usage of masks or PPE (Personal Protective Equipment) affecting the physiologic parameters is widespread. This pilot study is part of a bigger study that tries to explore the differences in the physiologic parameters when wearing respirator protection, before and after a validated six-minute walk test (6-MWT), which is a sub-maximal exercise test used to assess aerobic capacity and endurance.

Aim: To compare the changes in the physiological parameters of using a facemask (N95) and PPE assessed by a (6-MWT).

Materials and methods: This study followed a three-group quasi-experimental panel design. Nine subjects, aged between 18 to 50 years, who have received both doses of the COVID vaccine and residing in Ipoh, Perak participated in this study. The participants were randomly assigned into three groups (Control, Face mask, and PPE). Participants' heart rate, blood pressure, oxygen saturation (SpO_2), and aural temperature were recorded. A 6-MWT was chosen for its relevant environment and physical exertion that of a general population. A comparative analysis was done by one-way ANOVA.

Results: The differences in the physiological parameters between the control, face mask, and PPE groups, before and after walking for 6 minutes were not significant. The mean walking distance was not different among the three tested groups.

Conclusion: A 6-MWT was sufficient to explore the effects of a face mask and PPE in a setting similar to that of the general population. Adopting protective measures such as face masks or PPE does not change the normal physiological parameters and has a greater public health significance in the prevention and control of infectious respiratory diseases.

Keywords: *6-Minute Walk Test, PPE, walk-distance*

Introduction

The pandemic condition of coronavirus disease (COVID-19) has an impact on life in every aspect. The risk of exposure to the infection mandated the use of personal protective equipment (PPE) by health professions and by the general population. The prolonged use of face mask, face shield or full-body PPE may indeed produce discomfort and physiological effects [1]. Also, it affects the cardiopulmonary system during physical activity that needs assessment such as oxygen saturation (SpO_2), heart rate etc. The discomfort due to physical activity with face mask or PPE can be assessed by six-minute walk test (6-MWT), a submaximal exercise test as one of the methods used to assess aerobic capacity and endurance.

The impact of N95 filtering face-piece respirators (FFR) among the health care workers (HCW) had risen CO_2 levels and feeling of shortness of breath, headache, perceived exertion, and impeded communication [2]. Another study on the prolonged use of FFR revealed the effects due to hypoxic and hypercapnic symptoms, including local symptoms of dry nose, itchy and burning sensation in the nose, redness and sweating on the face etc [3,4]. Apart from the cardiopulmonary effects and metabolic shift, the impairment of cognitive function was also reported [5]. The reduced cardiopulmonary exercise capacity was reported on prolonged use of KN95 mask along with a 3-ply mask over it and wearing anti-fog goggles during work or physical exercise [6]. Cardiopulmonary parameters such as oxygen saturation, pulse rate and end-tidal CO_2 were reported for physical activity of brisk walk for 10 minutes on wearing face mask [7]. The effects of full body personal protective equipment (PPE) on cardiopulmonary parameters are not reported after 6-MWT.

The aim of the study is to establish the effects of face mask (KN95) and PPE on performance of 6-MWT, a submaximal exercise test which is one of the validated physical activity methods. Our hypothesis was that there would be no major impact of using face mask and PPE on physiological parameters.

Materials and methods

This study follows a three-group quasi-experimental panel design by Chang et al, 2014 [8]. After obtaining ethical approval, the participants were randomly separated into three groups (Control, Face mask, and PPE). One group of participants was a control group, whereas, among the remaining two groups, one group used a face mask (KN95) and the other to a full-body PPE. The unvalved face mask 3M 9501+. KN95 (China) AS/NZS 1716 P2 (Australia/New Zealand) with white ear loops were used. The full body PPE included head cap, shoe cover, body drape (Executive standard GB19082-2009, Hean Pharmaceutical Supervision Production, License No 20200216) with face shield and hand glove (latex- unsterilized). Each group underwent a pre-test and post-test measurement, where the intervention was a 6-MWT. In this pilot study, approximately 10% of the main study sample was involved. A total of nine subjects were randomly separated into three subjects in each group. The study was carried out in University Kuala Lumpur-RCMP in October 2022.

The following were included as inclusion criteria: being aged between 18 to 50, having received both doses of the COVID vaccine, and residing in Ipoh, Perak. Healthy employees and healthcare professions, students who identified with the term 'healthy volunteer' participated. Those with underlying cardiopulmonary illness or symptoms of active COVID-19 infection were excluded from participation.

The study was conducted after obtaining ethical approval from UniKL Research Ethics Committee. After explaining the procedure, all participants signed the informed consent. Data collection forms including personal details such as age, gender, contact number, and address were

collected. Also, they filled in the details of vaccination status and any medical illness / recent surgery. The physiological measurements such as height, weight, heart rate, blood pressure, transcutaneous oxygen saturation (SpO_2) and aural temperature (tympanic/aural digital thermometer) were measured. The fingertip pulse oximeter (Model:C101A2; iMDK, China) was used for measurement of SpO_2 and infrared multifunctional thermometer (TM 750 Medisana, Malaysia) MDA approved was used to measure aural temperature.

The 6-MWT was carried out according to the recommendations of the American Thoracic Society [9,10]. The participants had to walk as fast as possible without running for six minutes, they were encouraged in each minute to continue at the same pace and not to stop. At the end of the walk test, heart rate, blood pressure, oxygen saturation, and temperature were measured. The distance walked was measured.

The statistical analysis was performed with the SPSS Statistics program version 24.0. The mean and the standard deviation were calculated. For the comparative analysis, a one-way ANOVA test was used. The p-value < 0.05 was considered to be statistically significant.

Results and discussion

This pilot study as a part of an extensive study tried to investigate how the effects of wearing a facemask or PPE are different from not wearing any in respiratory protection. The anthropometric parameters of three groups: control, face mask and PPE were given in Table 1. The mean±SD of the physiological parameters and the p-value of comparison analysis among the three groups were provided in Table 2. From the results, there were no significant differences in the recorded parameters before and after the walk of each of the groups and between the groups. The 6-MWT is a validated test to record the changes in physiological parameters when a non-strenuous sub-maximal physical activity is done.

Previous studies showed that the recorded physiologic parameters after 6-MWT did not significantly change in a normal, healthy individual after wearing face mask [11,12]. The participants of this pilot study were young adults who had sound health and none of the participants experienced any adverse effects due to physical activity. Hence, our results are also compatible with these studies [11,12]. However, self-perceived dyspnea was highest among those wearing FFP2/N95 than those wearing surgical mask but there was no difference in heart rate, oxygenometry or respiratory muscle tone after performing the 6-MWT [13,14]. Similarly using different types of masks, surgical mask and N95 respirator; and graded activities such as walking, climbing stairs did not show significant changes in heart rate and blood oxygen saturation (SpO2) [15]. However, the heart rate and oxygen saturation were significantly different after wearing N95 filtering face-piece respirator (FFR) during prolonged work in the intensive care unit [1].

We recorded that the control group had the highest average distance covered during the 6-MWT followed by the face mask group and the PPE group (Table 2). But the mean distance covered by the three groups was found to be not significant statistically. We acknowledge this variation in the covered distance due to the limited physical mobility imposed by wearing the PPE, on the other hand, wearing a face mask would not be expected to limit physical mobility. In contrast, other studies conducted in healthy volunteers did not show the difference in distance walked, before and after wearing face mask [11,12,15]. Even patients with advanced lung diseases did not affect the six-minute walk distance (6-MWD) after wearing an oronasal surgical mask, therefore, a masked 6-MWT appears a reliable examination for functional exercise capacity [16]. Also, the participants in the PPE group were overweight as compared to

other groups. Test for an association between the BMI and recorded 6-MWD was not done for the small sample size in this pilot study. Previous study showed that an increase in BMI leads to a decrease in 6-MWD or less exercise performing capability with increasing body weight [17]. However, post-COVID patients who had severe pneumonia showed 6-MWD less than those with mild symptom and non-severe pneumonia but still not statistically different [18]. Recent evidence showed that PPE in the form of a smart face shield integrated with sensors (MAX30102) for measuring the heart rate, oxygen saturation (SpO_2) and the body temperature (DS18B20) [19]. The self-perceived dyspnea of the participants was not collected as the participants were majorly used to wearing some kind of PPE even before the beginning of the COVID-19 pandemic. Physiologic responses due to long term use of N95 mask are not completely studied, but current knowledge suggests that N95 mask may induce reaction to the carbon dioxide accumulated in the dead space of the mask [20].

Studies that investigated the issues from wearing a PPE or a face mask in the healthcare workers include increased sweating, headaches, breathlessness and some also reported a skin reaction like allergic dermatitis due to the composition of the PPE material [2,21]. A study found that around two-thirds of their participants had reported breathlessness due to wearing a PPE [21]. Also, another study found that breathlessness was mainly seen among participants who wore a PPE with a mask that did not have a valve [20]. Another study contradicts the above finding as absence of valve did not cause any significant physiologic changes when a PPE with no-valve N95 was used [22]. Nevertheless, wearing different types of masks such as surgical mask, cloth mask and N95 mask had no differences in oxygen saturation, heart rate, or blood pressure except that those with cloth masks and N95 masks resulted in more breathing effort than surgical mask [23]. Similarly, in our study there were no significant differences between systolic and diastolic blood pressures among three groups, before and after the walk ($p>0.05$).

This study is one of the first studies in Malaysia to investigate the physiological effects of wearing a respiratory protection such as PPE on the performance of 6-MWT. Very few studies exist that used a 6-MWT to evaluate changes in physiological parameters while wearing a facemask. Most studies that evaluated the effects caused by wearing a facemask was done by observational method or by employing exercise methods that do not necessarily reflect a natural working environment, while this study focused on using a validated method of physical exertion [24].

The limitation of this pilot study includes the issues with the non-matching of the participants of the three groups (control, facemask, and PPE). This issue would be dealt with in the actual study by randomization of the participants into the groups. The environment in which the participants performed this 6-MWT was not the same as other previous studies that targeted healthcare workers. But the environment in which the data collected was appropriate for the method chosen for the physical exertion (6-MWT) and participant characteristics (medical students).

Conclusion

Since the beginning of COVID-19, speculation surrounding the usage of face masks or PPE affects the physiological parameters is widespread. This pilot study found no differences in the recorded physiological parameters and contribute to the argument of laymen that wearing a face mask or PPE affects the normal functioning of the human body. Adopting protective measures such as wearing a face mask or PPE for the prevention and control of infective respiratory diseases has greater public health significance. From the findings of this pilot study, we recommend studies involving participants of various professions and with diverse validated physiological tests with similar testing groups

(control, face mask, and PPE) to expand the current knowledge on the influence of adopting a respiratory protective measure in the working environment. The larger study to which this pilot study has been conducted targets participants of healthcare field who exhibit a minimal physical exertion and long duration of wearing a PPE.

Author contributions

P-KM, N-BM, SNR-BA and RS-S contributed to conceptualization of a research project. P-KM, N-BM and SNR-BA conducted study and were responsible for data collection. P-KM and RS-S analyzed the results and contributed to manuscript writing and critical review.

Conflict of interest

The authors declare no conflicts of interest in the publication of this article.

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Table 1. Anthropometric parameters of three groups of subjects

Parameters	mean±SD		
	Control (n=3)	Face mask (n=3)	PPE (n=3)
Age (years)	19.00±0.00	19.00±0.00	20.67±1.52
Height (cm)	157.33±5.86	158.00±10.14	160.00±8.54
Weight (Kg)	47.67±3.79	57.53±10.42	64.97±15.05
BMI (Kg/m^2)	19.23±0.50	23.20±5.07	25.26±5.09

Table 2. Physiological parameters of three groups of subjects before and after walk in 6-MWT

Parameters		mean±SD Control (n=3)	Face mask (n=3)	PPE (n=3)	p-value
Heart rate	Before walk	92.67±6.43	83.67±12.06	86.33±12.10	0.59
(BPM)	After walk	112.00±11.36	86.67±23.44	87.67±7.37	0.16
SpO_2 (%)	Before walk	98.67±0.58	98.00±1.73	98.67±0.58	0.71
	After walk	98.00±0.00	98.33±01.16	97.33±2.08	0.68
SBP (mmHg)	Before walk	116.67±13.43	115.00±19.47	108.67±13.65	0.81
	After walk	135.33±13.61	117.00±8.00	121.33±15.31	0.26
DBP (mmHg)	Before walk	81.3±14.30	68.67±4.73	70.67±1.53	0.24
	After walk	78.67±13.20	80.67±6.66	78.33±6.35	0.95
Temperature	Before walk	35.43±0.38	36.07±0.26	35.43±0.58	0.19
(^{0}C)	After walk	35.23±0.92	35.43±0.58	35.33±0.78	0.95
6-MWD (m)	After walk	540.52±36.93	472.35±48.90	471.66±47.67	0.11

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