The Dilemma of Using N95 Masks for Health Workers

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Abstract. The N95 Particulate Respirator (N95 mask) is the highest filtering mask, but there are some complaints about its use, one of which is difficulty breathing. Objective. Therefore, this study aimed to determine whether the use of N95 masks had any effect on oxygen saturation, respiration rate, and complaint of shortness of breath. Methods. This study uses a convenient sampling technique with a sample size of 50 respondents. Settings. The setting area of this study was health workers at Budhi Asih Hospital Jakarta. The study design was quasi-experimental with a one-group pre and post-test design. Results. Data analysis used the Wilcoxon test with $p < 0.001$ means there is a difference in Oxygen saturation, respiration rate, and complaint of shortness of breath results before and after using an N95 mask. Conclusions. Because the effect of using N95 for a long time may decrease oxygen saturation, increase respiration rate, and complaint of shortness of breath, the researcher suggested that health workers and policymakers in Indonesia use N95 masks for a maximum of two hours to help health workers avoid illness, disability, and thereby maintain optimal performance.

Keywords: N95 mask · Oxygen saturation · Respiration rate · Shortness of breath · Health workers

1 Introduction

WHO recommends standard practice, namely the use of waterproof gowns, goggles, face shields, and N95 particulate respirator masks in accordance with National Institute of Occupational Safety and Health (NIOSH) standards [1] N95 mask is one type of mask with a high filtration rate of 95% [2] with a median particle size of 0,3 m^2 [3]· In addition to its function as self-protection from viruses, bacteria, and dust, masks have several side effects. Several studies have reported that the use of N95 masks can cause excessive fatigue [4], decreased oxygen saturation, anxiety [5], increased pulse rate, shortness of breath, and headaches [6]).

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Oxygen saturation, respiratory rate, and complaint of shortness of breath are benchmarks for a person's basic respiratory condition. Oxygen saturation is to determine the level of oxygen in the blood [7]. Similarly, respiratory rate and complaints of shortness reflect the clinical condition of the lungs.

N95 masks by WHO is only recommended for use by caregivers or health workers in various area settings [8]. The N95 type 8210 mask is one type of mask with a high filtration rate of 95% [2], particle filtration efficiency up to an average diameter of 0.3 m^2, and "N" means not anti-oil [1]. This respirator mask fits snugly on the face and closes right around the mouth and nose so that it is effective and optimal in filtering air particles [9]. The more optimal the level of protection, the more guaranteed and safe health workers are in providing health services.

On the other hand, to prevent the spread of infection, health workers wearing N95 masks are faced with several challenges, namely: experiencing difficulty breathing, discomfort, dehydration [10], decreased circulating oxygen concentration, increased pulse rate, a sensation of shortness of breath, dizziness [6], headache [11], extreme fatigue, increased fatigue [4] decreased oxygen saturation [5] and respiratory resistance [12].

Unlike the case with another study by Spang & Pieper (2021) found that there was no significant difference in the use of respirator masks in physiological, subjective, and behavioral conditions [13]. Another study also revealed no significant difference in CO_2 and oxygen saturation between those who did not wear a mask and used various types of masks, both at rest and brisk walking for 10 min [14]. The study presented by Kim et al. also stated the same thing that the pulmonary and PR responses in wearing a respirator mask for 1 h at low-moderate activity levels were relatively small and generally well tolerated by healthy people [15].

Examination of oxygen saturation levels, respiratory rate, and complaints of shortness of breath is an initial and easy examination to assess the condition of a person's respiratory function. Oxygen saturation is the percentage of hemoglobin that binds oxygen compared to the total amount of hemoglobin in the blood, so if only a small amount of hemoglobin binds oxygen, a person will feel shortness of breath, dizziness, and restlessness [16]. While the respiratory rate is the number of breaths (inspiration & expiration) in one minute, and the pulse frequency is the number of pulses in one minute. The normal percentage of oxygen saturation for all ages is 95%–100% [16], the normal respiratory rate in adults is 20 to 25 breaths per minute [17], and there is or is no complaint of shortness of breath in N95 mask wearers.

Low oxygen saturation in the body (<94%) can cause several health problems, including hypoxemia which is characterized by shortness of breath, increased respiratory rate up to 35 times per minute, rapid and shallow pulse, cyanosis, and decreased consciousness [18]. These three examinations can be carried out with one device, a peripheral oximeter, asking the user for complaints.

There is a gap between the findings of previous studies regarding the effects of using masks, especially N95 masks. Therefore researchers want to prove this concept in hospital area settings in Indonesia. From this data, it is necessary to evaluate the effect of using N95 masks, so that mask users remain safe and safe at work.

2 Method

This study used a quantitative design with a one-group pre-post-test approach. Before the research was conducted, respondents were given informed consent as a consent form. This research was conducted from Jul 25, 2022–Aug 5, 2022. The number of samples in this study was 50 respondents using the convenience sampling technique. The criteria included in this study were health workers who worked at Budhi Asih Hospital Jakarta, both in polyclinics and inpatients and working at least 2 h a day for one shift. At the same time, the criteria for respondents issued in this study were respondents who were pregnant, who were sick during the implementation of the study, and who took off their masks for less than 2 h of use.

The independent variable in this study was the use of N95 masks. The dependent variable was oxygen saturation, respiration rate, and complaints of shortness of breath. The observation sheet was used as an instrument to record the measurement results. A pulse oximeter of Microlife OXY 200 type was used to measure variable oxygen saturation. A wristwatch was used to measure respiration rate, and an N95 mask type 8210.

The first measurement was the respiration rate after obtaining approval from the respondents using the tools that had been prepared. Furthermore, respondents wore N95 masks for 2 h during the service shift. After 2 h, the respondent was again measured for oxygen saturation, respiration rate, and complaints of shortness of breath with the answer choices "yes" and "no".

This study used IBM SPSS 27 software. The univariate analysis described the data on the characteristics of respondents, namely age, occupation, and gender, as for the difference before and after using an N95 mask on the variables of oxygen saturation, respiration rate, and complaints of shortness of breath using the Wilcoxon test with a significance level of $p < 0.05$. This research has been declared ethically feasible by the Health Research Ethics Committee of Budhi Asih Hospital Jakarta under Number 329/KEP-ETIK/VII/2022.

3 Result

Data on the characteristics of respondents is based on Table 1. There were aged between 17–25 years as many as 17 respondents (34%). The profession of work in the Budhi Asih Hospital Jakarta was 36 nurses (72%). Finally, the gender of the respondents was found to be the most female (90%).

Based on Table 2, the average value of oxygen saturation before using the N95 mask was 99.68 ± 0.621. After using the N95 mask, the average value of oxygen saturation was 98.38 ± 0.780. The difference between before and after oxygen saturation was -1.3. The average value of the respiration rate before the use of the N95 mask was 18.78 ± 1.093. After using the N95 mask, the average value after the respiration rate was 20.52 ± 1.515. The difference between before and after the respiration rate was 1.74. There was a difference between before and after using an N95 mask on oxygen saturation and respiration rate with a significant p-value < 0.001 ($p < 0.05$).

Table 1. Data on the characteristics of health workers at Budhi Asih Hospital Jakarta (n = 50)

Characteristics	n	%
Age (year)		
17–25	8	16
26–35	17	34
36–45	16	32
46–55	9	18
Employment		
Nurse	36	72
Doctor	7	14
Pharmacy	5	10
Optometrist	1	2
Radiologist	1	2
Gender		
Female	45	90
Male	5	10

Table 2. Differences before and after the use of N95 masks on oxygen saturation and respiration rate in health workers at Budhi Asih Hospital Jakarta (n = 50)

Variables	*Before* (*Mean* ± SD)	Min-Max	*After* (*Mean* ± SD)	Min-Max	Delta	Z	P *value*
Oxygen saturation	99,68 ± 0,621	98–100	98,38 ± 0,780	96–100	-1,3	-6,304*	<0,001
Respiration rate	18,78 ± 1,093	16–21	20,52 ± 1,515	18–28	-1,74	-5,724*	<0,001

* based on negative ranks value

Table 3. The difference before and after the use of N95 masks on complaints of shortness of breath in health workers at Budhi Asih Hospital Jakarta (n = 50)

Variable	*Before*	*After*	Z	P *value*
Complaints of shortness of breath				
No	50 (100)	8(16%)	-6,481*	<0,001
Yes	0 (0)	42 (84%)		

*based on negative ranks value

Table 3 shows no complaints of shortness of breath before using the N95 mask for as many as 50 people. After using N95 masks, the complaints of shortness of breath increased by 42 people (84%). There was a difference between before and after the use of N95 masks on complaints of shortness of breath with a p-value < 0.001 ($p < 0.05$).

4 Discussion

It is known that since the era of the COVID-19 pandemic has been running for two years, health workers cannot be separated from the use of personal protective equipment. It is known that at the beginning of the pandemic, the use of N95 masks had a 95% filtration rate for particles less than 0.3 microns, which can protect against infectious respiratory diseases such as tuberculosis, SARS, and COVID-19 [19, 20] and surgical masks with an air filtration rate of over 90% [21]. Some health workers choose to use N95 masks as self-protection against the COVID-19 virus. This is in line with Geraldi et al., who stated that several health workers chose to use N95 masks more than surgical masks during the COVID-19 pandemic, even though it significantly affected the use [22].

The effect of using N95 masks is also known to have an impact on health workers. Most users of N95 masks cause headaches, rashes, acne, skin damage, and skin disorders in health workers [23]. This was also followed up by us regarding several physiological parameters of health workers in inpatients and polyclinics in the use of N95 masks for 2 h of use with moderate activity. The results of our study found that there was a difference in the mean before and after the use of an N95 type 8210 mask on health workers which caused a decrease in oxygen saturation in peripheral blood by 1.3%. This is also in line with several studies showing a decrease in oxygen saturation values using N95 masks [24]. The meta-analysis study proposed by Wangsan et al. also added that oxygen saturation showed lower values and higher partial pressures of carbon dioxide in high physical activity [25].

We also found the use of N95 in health workers that there was an increase in the average respiratory rate of 1.7x/min and complaints of shortness of breath by 6.4x higher in moderate to high activity of health workers for 2 h when using an N95 mask. Type 8210. This is also in line with the research proposed by Hassibi et al. that the use of N95 masks affects the body's physiological examination, namely oxygen saturation and respiratory rate after being measured by the presence of sports activities [26]. Increased pulse rate during wearing a mask both in a surgical mask during surgery in a period of use from 20 min to 120 min [6]. Wearing an N95 mask may cause a decrease in oxygen availability and an increase in the amount of carbon dioxide, which can lead to an exponential increase in heart rate and blood pressure, even at low workloads. These physiological changes can increase aortic and left ventricular pressures, increasing cardiac workload [27].

Changes in oxygen saturation, respiratory rate, and shortness of breath complaints can be influenced by individual habits. Our study used the type of Particulate Respirator N95 type 8210 USA standard, but almost 80% of respondents experienced complaints of shortness of breath, fatigue, and headaches. However, some felt that they had no complaints because they were used to using the previous type, the 9210 N95 Particulate Respirator. Both masks are standardized by the CDC regarding COVID-19 control and

have a filtration effectiveness rate of at least 95% filtration against solid and liquid aerosols that do not contain oil [28]. So the need for further investigation of these findings.

While working, all health workers did not have low activity, especially during the COVID-19 pandemic. We also did not find any signs of dangerous risk, even though some respondents experienced complaints within 2 h of use. A decrease in oxygen saturation and an increase in pulse rate is a physiological change within normal limits and does not have a harmful effect on health. The changes in vital signs may be due to an adaptive process. So physiologically, the use of N95 masks can be used in daily shift duties [29]. According to WHO recommendations, a maximum of 4 h for medical masks and 2 h for N95 masks. It also requires further evaluation if there is a significant change in a person's body condition. Another study added that the use of N95 masks could be used safely and appropriately even if a short-term moderate-strenuous activity is used because there are only small changes in physiological parameters unless someone with a history of lung disease should evaluate the wear if doing strenuous activities [30]. Another situation is that health workers who use full use for up to 4 h without a break with fatigue due to workloads and high activities need an initial evaluation because of the risk of hypoventilation [31]. Some of the limitations of this study are that we did not control the environment and temperature in the use of N95 masks and did not examine them in comparison with the group using only medical masks.

A study that supports our research is the incidence of side effects in health services using N95 masks while treating Covid-19 patients in the form of difficulty breathing (70.5%) even if used for more than 6 h (86.4%) [32]. This is also in line with research, which states that the use of N95 masks has an impact on respiratory symptoms [33].

This is likely due to the presence of humidity levels; wearing an N95 mask can increase respiratory resistance. It is known that if the N95 mask is used for more than 4 h, it can activate an automated breathing and metabolic simulator (ABMS). The ABMS plays a role in respiratory response variables such as dynamic consumption metabolism, ventilation volume, carbon dioxide production, respiratory rate, and pressure during inhalation and exhalation [34]. Although there are studies that other types of masks that are not N95 do not impact serious respiratory symptoms, only the Maximal Voluntary Volume (MVV) parameter is impaired due to the decrease in value due to the mechanical barrier provided by the mask [35].

5 Conclusion

The use of N95 masks has been shown to have an effect on decreasing oxygen saturation, increasing respiratory rate, and complaints of shortness of breath in health workers after 2 h of use by health workers at Budhi Asih Hospital Jakarta.

We suggest further research to assess the presence of a control group comparison and compare with other types of N95 masks used by several countries' standards. We also advise health workers about wearing N95 masks for a maximum of two hours and taking them off while resting.

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