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Evaluation of the Effect of N95/ffp2 Masks on Venous Blood Gas and Clinical Symptoms in Medical Personnel in Work Shifts

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Abstract
Objective: The use of N95/FFP2 masks by Healthcare Providers (HCPs) has increased throughout the COVID-19 pandemic. Long-term use of N95 respirators by healthcare professionals may cause changes in gas exchange. This study was aimed to investigated the effect of N95/FFP2 masks on venous blood CO2 and clinical symptoms in medical personnel in work shifts. **Method and Materials:** In this intervention study, staff working in Imam Khomeini Ahvaz Hospital who used N95/FFP2 masks were included. From the 32 personnel included in the study who did not wear N95/FFP2 masks 2 hours before the start of the work shift, and then after wearing the mask, in the middle of the shift (about 4 hours later), venous blood gas (VBG) samples were taken again. Then venous gases and clinical symptoms were compared before and after using the mask. **Results:** The level of PCO2 before and after using the mask was 42.77±2.68 and 49.39±4.88 mmHg, respectively. After wearin the mask, the level of PCO2 increased significantly (P=0.001). Based on our findings, there was no statistically significant difference in terms of blood PH value before and after masking (P=0.014). Headache and dizziness after wearing the mask were seen in 34.3% and 28.1% of participant. A significant difference was observed in terms of headache after using the mask(P=0.04), while dizziness after weaing the mask was not significantly different from before using it(P=0.06). **Conclusion:** Using an N95 respirator for prolonged periods by healthcare professionals may provoke changes in gas exchange. The clinical significance of these changes remains to be determined.

Key Words N95/FFP2 mask, COVID-19, Venous blood gas (VBG)

1. Introduction
Corona virus disease 2019 (COVD-19) is a respiratory tract infection caused by a novel coronavirus first reported in December 2019 in Wuhan, China, which is closely related to the severe acute respiratory syndrome virus(SARS) [1]–[3]. Following the outbreak of the COVID-19 pandemic, the use of respiratory masks has been widely recommended by regional, national and international bodies [4].

Protective masks used by hospital personnel who are in direct contact with infected patients must have the ability to prevent the entry of bacteria and viruses in the air or aerosol in the high-load environment of the hospital [5], [6].

The purpose of wearing a mask is to reduce the excretion of respiratory droplets in people before the onset of symptoms or in people without symptoms. The available evidence regarding face masks for reducing respiratory viral infections or improving clinical outcomes is mixed and controversial [6], [7].

Using breathing masks for long hours can have many physiological effects on hospital staff. For example, using breathing masks can cause dizziness and headache, difficulty breathing and other symptoms. There is also concern about the accumulation of carbon dioxide in the mask, and the increase in the level of carbon dioxide in the blood in the long-term use of breathing masks [7], [8].

Disposable surgical masks are intended to reduce user-to-patient virus transmission, hand-to-face contact, and face-to-face contact with large particles. FFP2 and N95 filter masks comply with the standards of filtering small particles in the air and fit tightly on the user's face [9], [10]. N95/FFP2 masks meet 95% standards to prevent the transmission of non-oily particles and bioaerosols (including viruses) [11], [12].

Due to the long-term epidemic of COVID19, and the widespread use of FFP2 masks in hospital personnel who need to use these masks for a long time due to the high risk of transmission of this infection, sufficient studies on the

Variable	Result	
Age (Year) (mean±SD)		32.47±6.39
Sex	Female	26 (81.25)
	Male	6 (18.75)

Table 1: Demographic characteristics of participant

physiological effects, PCO2 levels and symptoms Clinical use of FFP2 respirators has not been done [13], [14]. This study was conducted with the aim of investigating the effect of FFP2 masks on venous blood PCO2 and clinical symptoms in medical personnel during work shifts.

2. Method and Materials

The present study was conducted as an intervention on 32 medical personnel working in the COVID-19 ICU department of Imam Khomeini Hospital in Ahvaz, Iran in 2022. Inclusion criteria were personnel working 4-hour shifts while continuously wearing FFP2 masks. Improperness or wearing the mask badly were exclusion criteria.

Venous blood gas (VBG) samples were taken from personnel who did not wear FFP2 masks 2 hours before the start of the shift, and then after wearing the mask, in the middle of the shift (about 4 hours later) and just before changing the mask. To ensure the fit and appropriateness of the mask during the study, the sealing of the mask was checked at least twice in each shift.

Before weaing the mask, the grading of symptoms such as headache and dizziness before and after the intervention was measured using relevant scoring questionnaires. The ethics committee of Ahvaz Jundishapur University of Medical Sciences was approved this study.

A. *Statistical analysis*

Statistical analysis was accomplished by SPSS software version 26. The quantitative and qualitative variables were indicated as mean±SD and number (percentage), respectively. Kolmogorov–Smirnov and, Shapiro–Wilk tests were used to test for the distribution. Differences were compared by using the t-test or Mann–Whitney U test as appropriate. P-value less than 0.05 was considered statistically significant.

3. Results

The mean age of the participants was 32.47±6.39 years. 81% of the participants were female. The age of male and female did not differ significantly (P=0.25) (Table 1).

The level of PCO2 before and after using the mask was 42.77±2.68 and 49.39±4.88, respectively. After using the mask, the level of PCO2 increased significantly (P=0.001). The mean PH before and after using the mask was 7.35±0.04 and 7.33±0.04, respectively, and there was a statistically significant difference in pH before and after the intervention (P=0.014). Headache and dizziness after wearing the mask were seen in 34.3% and 28.1% of participant. A significant difference was observed in terms of headache after using the mask(P=0.04), while dizziness after weaing the mask was not significantly different from before using it(P=0.06) (Table 2).

Variable	Before using the mask	After using the mask	P-value
PCO2 (mmHg)	42.77±2.68	49.39±4.88	0.001
PH	7.35±0.04	7.33±0.04	0.014
Headache	3 (10.6)	11 (34.3)	0.04
Dizziness	3 (10.6)	9 (28.1)	0.06
PCO2: Partial pressure of carbon dioxide.			

Table 2: Clinical and laboratory features before and after the wearing the mask

4. Discussion

The current study was conducted with the aim of investigating the effect of N95 mask on venous blood PCO2 and clinical symptoms in medical personnel during work shifts. Based on the findings of our study, there was no statistically significant difference in terms of pH value before and after using masking. The results related to PCO2 showed that after using the mask, the amount of PCO2 increased significantly.

In a study by Ong et al., which was aimed at mask-related headaches among health care workers, the results showed that among 158 individuals, 81% reported headaches related to respiratory masks. Also, since the outbreak COVID-19, 91.3% of the respondents with previous headache agreed that the use of respiratory masks affected their headache control, which also had a negative effect on their job performance [8]. The results of this study are consistent with our findings. In the current study, 34% of individuals reported headache after wearing the mask, and it was significantly different from before using the N95 mask.

Lim et al. reported headache in 37.3% of participants after using N95 and associated this finding with the increase in inhaled CO2 [15]. In another study, it has been suggested that the use of face filtering masks may lead to CO2 retention. These findings were supported by laboratory studies.

According to the results of the study by Ipek et al. the use of N95 significantly increased the rate of headache, respiratory distress, and drowsiness compared to surgical masks. The primary focus of this study was dizziness, but no difference was observed between N95 and surgical mask use in this regard. Participants in the study by Ipek et al. reported significantly more attention deficits and difficulty concentrating when using the N95 than when wearing a surgical mask [16].

In the study of Nafisah et al, which was conducted with the aim of evaluating the effect of the N95 mask on the concentration of carbon dioxide (CO2) and oxygen (O2) in the blood. The results showed that there was a significant difference in the PCO2 level between before and after using the mask (P<0.050). Also, a significant difference was observed in the level of the first and second PO2 (P<0.05) [17]. The results of this study are in line with the findings of the present study.

In the study by Yalciner et al., wearing an FFP3 mask for 4 hours did not statistically change any venous blood gas parameters between before and after values. Headache, lightheadedness, blurred vision, shortness of breath, heart palpitations, confusion and communication problems showed

a statistically significant difference between the before and after values. Four hours of FFP3 mask use produced a significant change in VBG [18]. The results of this study are similar to our findings.

This study has several limitations. The first limitation is the small number of sample sizes, which reduces the power of statistical analysis. Moreover, the control group without N95 mask was not possible due to safety issues.

5. Conclusion

Continuous wearing of N95/FFP2 mask for a long time significantly increases PCO2 and causes headache. However, it is unclear whether these physiological parameters produce a clinical effect in a healthy individual. Frequent removal of the N95/FFP2 mask within four hours is advocated to maintain health. The clinical significance of these changes in terms of symptoms or long-term health status is unknown and needs to be determined.

Conflict of interest

The authors declare no conflict of interests. All authors read and approved final version of the paper.

Authors Contribution

All authors contributed equally in this paper.

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