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RESEARCH ARTICLE

Effect of Various Types of Face Masks on Oxygen Saturation, Heart Rate & Respiratory Rate in Health Care Workers of Tertiary Teaching Hospital, Raipur (C.G.)

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Abstract

Background: Healthcare workers are at a higher risk of having Covid infection than other professionals. Thus, it is more important for them to wear face masks for themselves and for the sake of their co-workers and public health. The use of face masks is mainly limited by their perceived discomfort and concerns regarding inadequate gas exchange. Still, there are serious concerns about the use of masks over a long period.

Aims: This study aimed to study the effects of different types of face masks on clinical parameters like oxygen saturation, Respiratory rate, and pulse rate.

Methods: A cross-sectional observational study was conducted on 218 subjects from March 2021 to April 2021. They used different types of masks-like cloth masks, surgical masks, N95 masks, and double masks. A pulse oximeter applied to the index finger was used for the non-invasive determination of clinical parameters like oxygen saturation, heart rate, and respiratory rate.

Results: There was a significant decrease in oxygen saturation seen in subjects using the surgical mask and N-95 mask, but there was no change in oxygen saturation in participants who wore cloth masks. In our study, heart rates increased significantly at the end of the study in all groups irrespective of the mask they wore. However, the respiratory rate increased significantly only in those participants who wore N-95 masks.

Conclusion: Our study concludes that wearing a face mask for a long period induces an increase in heart rate and shortness of breath along with a significant reduction in oxygen saturation.

Keywords: COVID-19, SpO₂, Mask, Pulse Oximeter.

INTRODUCTION:

Background - Face masks are the first and most important protection against the pandemic COVID-19.^[1] The outbreak of COVID-19 has led to guidelines recommending the routine use of facemasks by the population, particularly healthcare workers.^[2] Healthcare workers are front-line warriors of the covid pandemic, as they care for infected individuals and thus come into direct and close contact with them. Health professionals were more likely to have severe COVID-19 than those in other professions^[3]. This makes it more important that they wear face masks, as even a small mistake on their part can have serious consequences, not only for themselves but also for other people and their co-workers. Although Face masks are recommended to prevent the spread of SARS-CoV-2, they pose some concerns among people wearing them like as inadequate gas exchange, breathing difficulty, and palpitations which are also important reasons for non-adherence. Compliance rates and practice of facemask use have remained poor among healthcare workers worldwide.^[4-6]

Aims and scope of Article - Our aim is to study different types of face masks used by healthcare workers during the COVID-19 pandemic and their impact on clinical parameters like oxygen saturation, Respiratory rate, and Pulse rate.

The problem addressed - The normal arterial oxygen levels range from 75-100 mmHg, and Normal pulse oximeter reading varies from 95-100%. Oxygen levels below 60mmHg necessitate the use of supplemental oxygen.^[7] Prolonged use of face Masks, compromises

oxygen uptake, trapping air in face masks thereby increasing rebreathing of CO₂ leading to hypercapnic hypoxia and increased work of breathing.^[8] Different types of face masks like N-95 masks, FFP2, surgical masks, face masks with valves, and even fabric masks made of cotton or synthetic offer different types of protection and have a different impact on clinical parameters.

Though various controlled studies in healthy individuals refuted the fears of face masks decreasing oxygen saturation (SpO₂).^{[9][10]} Still, there are serious concerns and fears about the use of face masks over a long period of time. That's why we have planned this study.

METHODS:

A cross-sectional, observational study was conducted among Healthcare workers of Pt. JNMMC, Raipur from March 2021 to April 2021 after obtaining approval from the ethics committee. 218 healthcare workers were enrolled in the study on the basis of the following criteria.

Inclusion criteria

- Health Care Workers of Pt. JNMMC, Raipur wearing a mask
- The age group of 25 to 65 yr.

Exclusion criteria

- Acute upper respiratory tract infection or symptomatic rhino-sinusitis with obstructed nasal passages on the study days.
- Comorbidities such as anemia, chronic heart failure, cardiac surgery, COPD, and Asthma.
- Tobacco Addiction either in form of chewing or smoking.
- People wearing N95 masks with an expiratory valve.

PROCEDURE:

Written informed consent was first taken from all the participants. Their demographic details were noted in a pre-approved proforma, along with the type of face mask/masks worn by them. Participants were asked to wash their hands thoroughly. They were made to sit comfortably in a chair and relax for a few minutes before measuring the SpO₂, Pulse rate, and respiratory rate. The pulse oximeter [Hand-held Smartsigns® MiniPulse MP1R (Huntleigh Healthcare Ltd, UK)] was placed on the person's index or middle finger ensuring that the sensor is firmly placed. Wait a few seconds for the reading to stabilize. (ideally 5 seconds) and note the Pulse rate and SpO₂ level. Respiratory rate was measured by counting the number of times the subject's chest or abdomen rises over the course of one minute. Subjects were then advised not to remove their masks for 1 hour. After 1 hour, all the vital parameters were recorded again, taking similar aseptic precautions. Compare

both the readings and subjects to statistical analysis by using IBM Statistical Package for Social Sciences (SPSS) statistical package version 25. The distribution of variables was calculated by Mean ± Standard. Paired t-test was used to compare the difference in mean of the two groups. Statistical significance was determined by a p-value of <0.05.

RESULT:

Among 218 eligible participants, 194 participants completed the study, the rest were excluded who broke the seal of the mask while participating in the study. In our study 19.07% (37) were women and 90.82% (157) were men. Out of a total of 10.8% person has comorbidities like Diabetes Mellitus (05), Hypertension (11), Hypertension and diabetes mellitus (03), and others (02).

Different types of masks used are cloth masks 55.15% (107), surgical masks 32.47% (63), and N95 masks 12.37% (24). The mean ±SD of different variables are listed below in Table-1.

Table-1

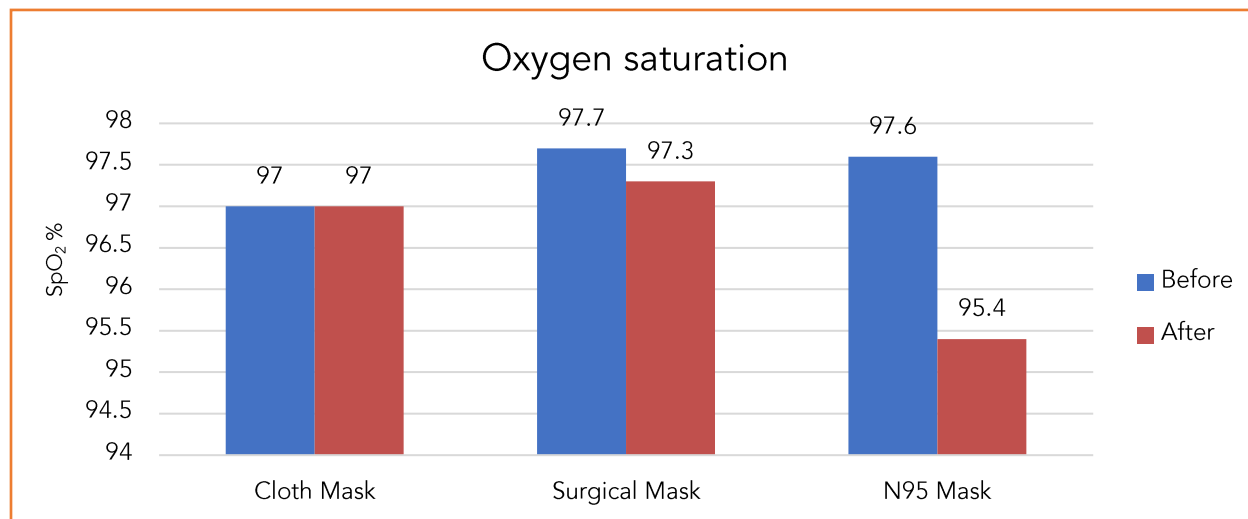
Type of masks	Variable	Mean+SD	
		Before	After
Cloth Mask	Oxygen saturation	97% ± 2.3%	97% ± 2.1%
	Heart rate	83.8 ± 9.8	86.2 ± 10
	Respiratory rate	20 ± 3.1	20.4 ± 5.5
Surgical Mask	Oxygen saturation	97.7% ± 1.2%	97.3% ± 1.5%
	Heart rate	85.6 ± 10.2	91.1 ± 9.5
	Respiratory rate	20.8 ± 3.5	20.9 ± 2.6
N95 Mask	Oxygen saturation	97.6% ± 0.9%	95.4% ± 1.5%
	Heart rate	85.6 ± 9.5	88.6 ± 9.4
	Respiratory rate	19.7 ± 2.2	21.8 ± 2.7

Oxygen saturation:

There was a statistically significant difference in oxygen saturation in those participants, who wore a surgical mask (N= 63) before and after ($97.7\% \pm 1.2\%$ Vs $97.3\% \pm 1.5\%$; $P = 0.009$), and in those participants, who wore

an N-95 mask (N= 24) before and after ($97.6\% \pm 0.9\%$ Vs $95.4\% \pm 1.5\%$; $P < .001$). There was a Nonsignificant difference before and after the use of cloth masks (N=107) ($97\% \pm 2.3\%$ Vs $97\% \pm 2.1\%$; $P = 0.744$).

Figure - 1 Oxygen Saturation

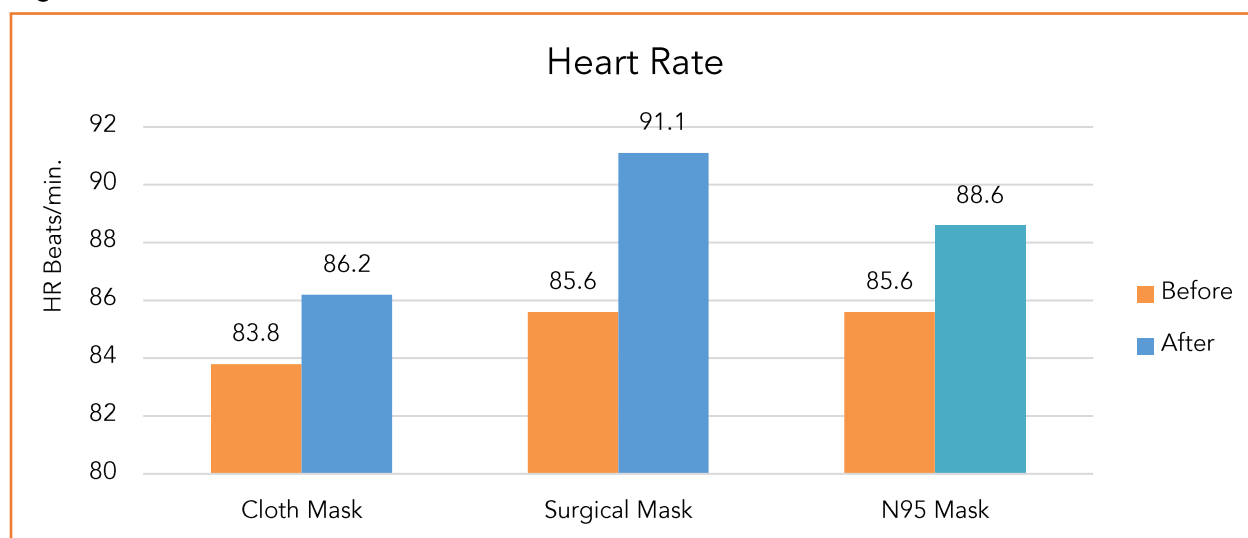


Heart Rate:

There was a statistically significant difference in heart rate when either type of mask was used for one hour. For participants who wore cloth masks only, (83.8 ± 9.8 Vs 86.2 ± 10 ; $P <$

$.001$), and who wore a surgical mask (N= 63) only, (85.6 ± 10.2 Vs 91.1 ± 9.5 ; $P < .001$), and in those participants, who wore N-95 mask (N= 24) ,(85.6 ± 9.5 Vs 88.6 ± 9.4 ; $P = 0.009$).

Figure - 2 Heart Rate

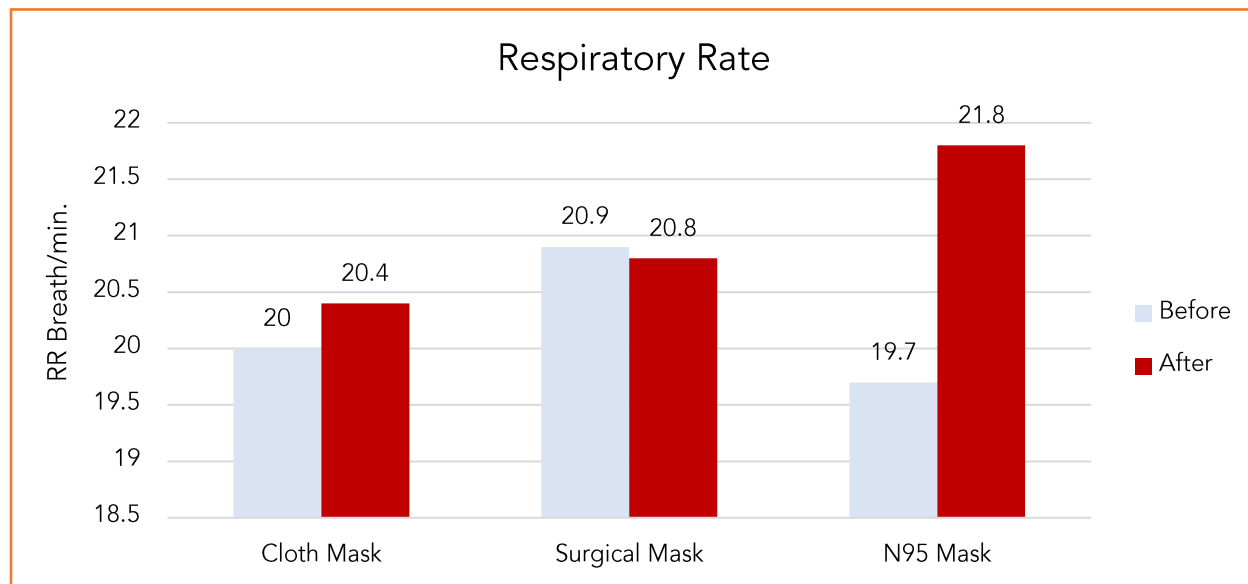


Respiratory Rate:

There was a statistically non-significant difference in those participants who wore cloth (N=107) masks only (20 ± 3.1 Vs 20.4 ± 5.5 ; $P = 0.4$) and who wore surgical masks (N= 63) only, (20.8 ± 3.5 Vs 20.9 ± 2.6 ; $P =$

0.68). But in those participants, who, wore the N-95 mask (N= 24) only, there was a significant difference between before and after the use of the N-95 mask (19.7 ± 2.2 Vs 21.8 ± 2.7 ; $P < 0.001$).

Figure - 3 Respiratory rate



Discussion

During the COVID-19 pandemic it became apparent how useful protective masks were among health workers and for the whole population.^[11,12] Before the era of the COVID-19 pandemic protective masks were widely used by healthcare workers, mostly surgeons as protection for the operated patient. The primary purpose of wearing masks was to protect the surgical patient from pathogens expelled on droplets from the nose and mouth of surgical personnel during speech, coughing, and sneezing, but more recently protective masks have been advocated as a protective barrier for the wearer from splashes and spills of body fluids.^[13] Few studies have

investigated the physiologic impact of medical masks on human subjects, but the outcomes have been contradictory. Some of these suggest that despite the perceived discomfort with their use, facemasks do not impose clinically relevant adverse effects, even with use over a long duration and in hot humid environments. However, the use of the masks for many hours causes problems such as hypercapnia, headaches, shortness of breath, runny nose, dark circles under the eyes, skin lesions, ear pain, or localized compression pain.

According to Fikenzer et al., in healthy individuals, ventilation, cardiopulmonary

exercise capacity, and comfort are reduced by surgical masks and highly impaired by FFP2/N95 face masks thus significantly impairing the quality of life of their wearer.^[14] There was a significant decrease in oxygen saturation seen in subjects using a surgical mask and N-95 mask, but there was no change in oxygen saturation in participants who wore cloth masks. In our study, heart rate increased significantly in all Participants. While the respiratory rate increased significantly only in those participants who wore N-95 masks. This is in concordance with a study by Dirol H. et al., that there is a significant increase in heart rate, respiratory rate, EtCO₂, and a significant decrease in SpO₂ level in walking tests during exercise with a surgical face mask.^[15] Similarly, Wojtasz et al concluded that found statistically significant differences in terms of SpO₂ and HR; nevertheless, the absolute median difference between the start and finish did not exceed 1–2% for SpO₂.^[16] In contrast, Arinze Duke George Nwosu et al., Reported that, neither the N95 mask nor the surgical mask impacts a change in the subject's oxygen saturation during use.^[17] Roberge *et al.* also reported no difference in their SpO₂ from those who wore no masks.^[18] A study by Majek et al, showed that physical activity in a protective mask did not affect oxygen saturation, heart rate, blood pressure, or respiratory rate. Additionally, there were no cases of moderate or severe dyspnea after the exertion performed with a mask.^[19] Tabansi and Onubogu in a cross-section stud of Nigerian health workers in different

departments over an 8-hour period reported no significant differences in the mean SpO₂ over the duration, irrespective of the masks they wore.^[20] In small studies (n≤20) by Kim JH.et al., and Rebmann T.et.al, observed that medical face masks did not cause clinically significant changes in heart rate, oxygenation, or ventilation.^[21,22] In a study done by nwsu et al N95 respirator mask imposes significantly more discomfort on the HCWs, than the surgical mask. However, neither mask type was associated with any significant change in oxygen saturation during use in routine clinical duty.^[23]

Conclusion

The main conclusion emerging from our study is, wearing a face mask for a prolonged time leads to a reduction in oxygen saturation without clinical relevance, along with an increase in heart rate and feelings of shortness of breath. Study limitations include a single-center study, mainly male participants, and limited follow-up duration. In order to make a more obvious conclusion, the duration of mask-wearing could have been longer to exclude other factors like physiological variables such as fatigue. Another limitation of our study is the impact of different types and brands of masks, which may be related to the sealing of the mask. Furthermore, the study should evaluate the psychological status of the participants, especially during the Covid period, like, anxiety, and stress, since these conditions can affect results and can be a source of bias in the result.

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Conflict of Interest

There is no Conflict of Interest

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