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## RESEARCH ARTICLE

### IMPACT OF N95 FILTERING FACEPIECE RESPIRATOR AND SURGICAL MASKS ON THE BLOOD OXYGEN SATURATION, HEART RATE AND BLOOD PRESSURE OF HEALTHY DENTISTS

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#### ABSTRACT

**Background:** Corona virus disease 2019 is now a global crisis that needs thoughtful attention. This situation endangers the dental profession as it is mostly based on aerosol-generating procedures. To prevent spread of infection and cross-contamination, use of personal protective equipments including N95 masks or surgical masks is crucial. Along with the prevention of infection, the masks might pose physiological effects. **Aim:** This study aimed to evaluate the impact of N95 respirator and surgical masks on the blood oxygen saturation, heart rate and blood pressure of healthy dentists. **Methodology:** The present study is designed as a cross-sectional survey including healthy dentists. Blood oxygen saturation (SPO<sub>2</sub>), heart rate(HR) and blood pressure (BP) were recorded for N95 and surgical mask groups separately. Collected data was statistically analyzed based on student-t test. **Results:** The 1 hr SPO<sub>2</sub> and HR values for N95 respirator were statistically significant. No significant change in blood pressure observed for both N95 and surgical masks. **Conclusion:** The use of short duration N95 masks has impact on blood oxygen saturation and heart rate of healthy dentists. There was no impact on blood pressure in both N95 and surgical masks.

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## INTRODUCTION

The outbreak of Covid-19 (Coronavirus Disease 2019) rapidly surged into a global pandemic, leading to a worldwide health and monetary crisis. The novel virus responsible for the predicament was initially designated as Wuhan coronavirus (CoV). Currently it is referred to as severe acute respiratory syndrome (SARS)-CoV-2 (Prasad, 2020). In the past, many countries have experienced various epidemics like H5N1, H1N1, SARS, Nipah, Ebola and avian influenza, which were successfully dealt with (Mathur, 2020). Dentistry is facing its darkest hour owing to the high rate of transmission of the disease through aerosols and splatter. Considering the usage of handpiece and ultrasonic scalers during routine dental procedures that generate aerosols, it is very crucial to consider safety measures to maintain a healthy environment both for the dental team and the patients. According to Occupational Safety and Health Administration (OSHA), dental health care personnel (DHCP) are at high-risk of contracting the disease as they have to work in close proximity to the oral cavity of the patient (Centers for Disease Control and Prevention).

DHCP are in need of upgrading their skills and knowledge regarding efficient infection control to prevent cross-infection between them and the patients as well. Usage of N95 masks and surgical masks has become an emotive subject in recent times. The N95 designation implies that under test conditions, the mask prevents the passage of at least 95% of solid and liquid aerosol test particles (certified under 42 CFR 84 of National Institute for Occupational Safety and Health and the United States CDC) (Gammaitoni, 1997). In spite of the protective efficacy, the effects of long duration usage of the masks on respiratory function and microclimate as well as the individual perceptions have to be taken into account. Literature suggests that surgical masks are associated with less feeling of discomfort, lower sensation of heat and humidity, and less resistance to breathing as compared to N95 masks (Li, 2005).

Long term usage of N95 masks has been reported to induce psychological stress and headaches among health care personnel (Lim, 2006). No study available yet to reveal short duration effects of N95 masks on dental professionals. The present study aims to compare the blood oxygen saturation, heart rate and blood pressure following short term wearing of N95 and surgical mask respirator respectively.

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## MATERIALS AND METHOD

A cross-sectional study was designed for one month duration among 10 healthy dentists (4 men and 6 women) aged less than 35 years. A thorough history was taken to exclude subjects with chronic illness including diabetes, hypertension, pregnancy, asthma, COPD, other lung diseases and immunosuppressive disorders. No participant has history of smoking for last 10 years. Clearance from institutional ethics committee was done and a written informed consent was taken from each dentist. Participants were divided into two groups i.e. N95 and surgical mask groups. Observations were made before and after a short duration dental surgical procedure (30 minutes to 1 hr).

The documentation of initial (just after wearing mask) and final (1 hr) readings were done irrespective of the amount of exertion among dentists for varied procedures. The blood oxygen saturation (SPO<sub>2</sub>) was measured by pulse oximeter (Mr GR8 Finger pulse oximeter PO01) for evaluation of the effect of N95 mask (3M 8210 N95) and surgical masks (Surgicare Shoppie Pharma and Surgical Distributors). The initial and 1 hr post wearing effect for both masks were observed in the same dentist group with 20 minutes rest period for every initial and final record on same day. Systolic and diastolic blood pressure (SBP and DBP), heart rate (HR) were also measured on the same day [Table-1]. The total number of observations was 300 for 15 days. All the data obtained were subjected to statistical analysis with help of Prism 5.04, Graphpad software, CA, USA, to calculate the means with corresponding standard deviations. The analysis of data was calculated based on student t test value with Confidence level 95%. The statistical significance was set at  $p < 0.05$ .

**Table 1. Format for documentation of reading**

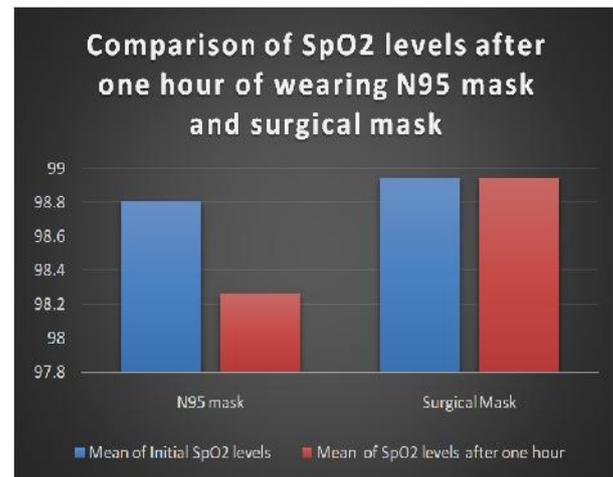
Dentists	Initial Reading		Final Reading (1 hr)	
	Surgical Masks	N95	Surgical Masks	N95
Dentist 1	SPO2 BP HR	SPO2 BP HR	SPO2 BP HR	SPO2 BP HR

## RESULTS

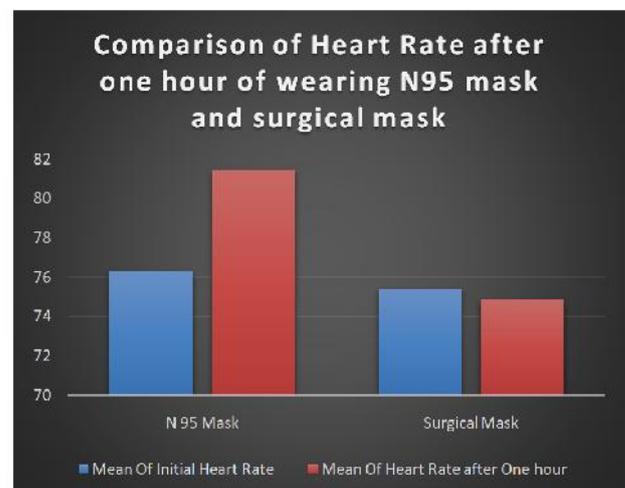
The Table- 2 shows means with corresponding standard deviations. The values suggested that short duration wearing of N95 masks have impact on final blood oxygen saturation and heart rate of healthy dentists.

**Table 2. Mean values with standard deviations for both N95 mask and double surgical mask**

Variables	N95 mask (mean±s.d.)		Double surgical mask (mean±s.d.)	
	Initial values	Final (1 hr) values	Initial values	Final (1 hr) values
SPO <sub>2</sub>	98.81±0.39	98.26±0.48	98.94±0.23	98.94±0.23
HR	76.30±8.07	81.43±6.81	75.40±5.36	74.86±5.16
SBP	117.59±6.37	77.27±9.01	117.56±5.76	77.35±6.19
DBP	117.13±5.42	78.12±8.71	117.17±6.07	77.60±6.23



**Graph 1. Comparison of 1 hr SPO<sub>2</sub> values of N95 respirator and Surgical mask**



**Graph 2. Comparison of 1 hr Heart Rate values of N95 respirator and Surgical mask**

In this study, the difference of 1 hr SPO<sub>2</sub> values for N95 was statistically significant ( $p < 0.0001$ ) but in case of surgical mask, no significant difference ( $p > 0.05$ ) was observed. Similarly, there was significant change in final HR value of N95 respirators ( $p < 0.0001$ ) where HR value of surgical masks had no significant change. No statistically significant difference ( $p > 0.05$ ) was found between systolic and diastolic initial and 1 hr blood pressure values of N95 and surgical masks.

## DISCUSSION

The first documentation of COVID-19 infection noticed in late 2019 in China as an aggressively spreading disease. This viral disease became pandemic in a very short span of time leading to a new face of 2020 with extensive community outbreak. For the risk of community transmission, it is essential to identify and implement measures with different mode of prevention. Protective behaviors and actions at the individual level can limit transmission at the community level. Mask is the part of preventive measures that can reduce spread of respiratory diseases to a certain extent (Robertson). According to WHO, universal masking is essential for health workers to reduce the potential transmission of infectious diseases among health workers and patients.

Respirators and surgical masks used in the regular dental operatories are two important examples of personal protective equipment to protect the users from airborne particles and liquid contamination. The performance of medical masks are tested according to a set of standardized test methods to balance high filtration, sufficient breathability and fluid penetration resistance (<https://www.who.int/publications-detail/global-surveillance-for-covid-19-caused-by-human-infection-with-covid-19-virus-interim-guidance>). The main difference in N95 and surgical mask is in design and secondly is the filtration ratio. A surgical mask is a disposable, loose-fitting device that creates a physical barrier between the mouth and nose of the wearer with surrounding environment. A surgical mask helps to block large-particle droplets, splashes, sprays, or splatter that may contain germs (viruses and bacteria) where respirator is a mask like respiratory protective device designed to attain a very close facial fit and very efficient filtration of airborne particles (Talhalm, Thomas, 2020; CDC).

During respiration, exchange of oxygen and carbon dioxide occurs through inhalation and exhalation process. When exhaling into a mask, there is a potential to inhale a greater amount of carbon dioxide, due to the exhaled carbon dioxide being trapped between the face and mask. According to Jewell, 2005 symptom of an excess of carbon dioxide in the blood, or hypercapnia, is fatigue. Lack of oxygen could cause hypoxia, that may leads to shortness of breath, confusion and even death (Jewell, 2005). The amount of oxygen in a person's blood can be measured using a pulse oximeter. A normal pulse oximeter reading will vary between 95- 100%. Relatively little research has been conducted regarding the physiological effects of wearing a mask. Hence, the present study was done to evaluate the effect of masks wearing in clinical situation among the dentists (Roberge, 2010).

In dentistry, most of the operative and surgical procedures are short duration (30 minutes to 1 hr). Considering this matter, the observations were made for 1 hr post-mask wearing physiological effects. Protective equipments like masks must have some physiological burden on users. It is also factual for dental surgeons who are truly vulnerable to get infections transmitted through inhalation and aerosol generation. Mask users may face health and mental stress to get sound protection.<sup>12</sup>In this study, physiological changes were observed for both N95 and surgical masks. The protective efficacy of respirators and surgical masks has been extensively compared and debated. Loeb *et al.* (2009) documented that surgical facemasks are not inferior in comparison to N95 respirator, in preventing laboratory-confirmed influenza whereas, Chu *et al.* reported that use of N95 respirators were associated with greater reduction in risk of infection among health care workers than medical masks. On the contrary, another study by MacIntyre *et al* inferred that the rate of infection with surgical mask was two times higher than that of with N95 respirator (MacIntyre *et al.*, 2011). Nevertheless, the difference in protective function of the two devices has been a controversial topic and is still inconclusive. The oxygen saturation may vary with the different properties of the materials with which the masks are manufactured, like lower air and water vapor permeability in N95 masks.<sup>16</sup> The possible reason for decrease of SPO<sub>2</sub> is the entrapment of moisture and heat beneath the mask that paves the way for entrapment of the exhaled carbon dioxide resulting in decreased blood oxygen saturation. Our study showed that the difference of 1 hr SPO<sub>2</sub>

values for N95 was statistically significant. A study done by R J Roberge *et al*, 2010, found no significant changes in blood oxygen saturation, heart rate and respiratory rate in control and filtering facepiece respirator (FFR) after 1hr.<sup>12</sup>Current study revealed that there was significant change in final HR values indicating impact on heart rate. Studies comparing control and FFR, demonstrated non-significant differences in heart rate after 1 hr. (Li, 2005; Jones, 1991; Laferty, 2006). No statistically significant difference was found between systolic and diastolic initial and 1 hr blood pressure values for both N95 and surgical masks. These observations are indicative of insignificant impact of both masks on blood pressure.

## Conclusion

Short term wearing of N95 masks poses significant changes in blood oxygen saturation and heart rate despite of its disease prevention efficacy. But short duration use of surgical masks has no impact on blood oxygen saturation and heart rate of healthy dentists. There was no impact on blood pressure in both N95 and surgical masks. Present study did not measure the amount of exertion that can be varied depending on duration and type of surgical procedures for each dentist. The physiological changes may vary with height, weight and sex. Therefore, study with more samples with extended variables will ensure the fact more accurately.

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