Advances in Medical, Pharmaceutical and Dental Research Journal (AMPDR)- ISSN 2812-4898
http://dx.doi.org/10.21622/AMPDR.2022.02.1.015

June 2022
Volume 2
Issue 1

Blood Oxygen Level with Long-Term Use of N95 Face Mask in Dental Practice during Coronavirus Pandemic "Covid-19"

Amr Bayoumi[1], Maha Shawki[2], Amro Abdulaziz[3], Mohammed Allam[3] and Mohamed Mosleh[4]

[1]Professor of Oral and Maxillofacial Surgery, Faculty of Dentistry, King Abdulaziz University, Jeddah, KSA and Alexandria University, Alexandria, Egypt.
[2]Professor of Oral and Maxillofacial Surgery, Faculty of Dentistry, King Abdulaziz University, Jeddah, KSA and Cairo University, Cairo, Egypt.
[3]General practitioner at Faculty of Dentistry, King Abdulaziz University, Jeddah, KSA.
[4]Assistant professor of Oral and Maxillofacial Surgery, Faculty of Dentistry, Beni-Suef University, Beni-Suef, Egypt.

Email: mobayme@kau.edu.sa, mmokhaimar@kau.edu.sa, Amro_Abdulaziz@hotmail.com Mohammed.f.allam@gmail.com, mohamed_mosle7@hotmail.com

Received on, 13 April 2022 - Accepted on, 30 May 2022 - Published on, 28 July 2022

Abstract:

Wearing a mask for a long time, particularly N95, is sometimes uncomfortable, annoying, and confining, making catching breath difficult and reducing the oxygen level in the blood. The study aimed to investigate the change in blood oxygen level when wearing an N95 mask for three hours among dental practitioners in dental clinics and the impact of low O2 levels on the general status of students while working in a stressful environment.

Material and methods: *The sample included 82 adult healthy senior dental students attending the student oral surgery clinical sessions. All Participants had their oxygen saturation SpO2 measured using a portable pulse oximeter before, 1 hour, 2 hours, and 3 hours after wearing the mask, and were allowed to describe their feeling of discomfort throughout the study. Systolic and diastolic blood pressure (SBP and DBP), and heart rate (HR) were also measured before and 3 hours after wearing the mask.*

Results: *84.15% (n= 69) of the participants reported some discomfort affecting their general status and clinical performance. There was a statistically significant increase in mean heart rate after three hours (P-value = 0.001) while there was no statistically significant change in mean systolic/diastolic blood pressure after three hours (P-value = 0.630) and (P-value=0.407), respectively. On the other hand, the mean oxygen saturation after three hours showed a statistically significant lower value compared with baseline measurement.*

Conclusion: *This study revealed a decrease in the oxygen saturation (SpO2) and a slight increase in pulse rate compared to baseline values in all students three hours after wearing an N95 face mask. In addition, the N95 mask induced discomfort in breathing, a decrease in physical performance, and increased fatigue not related to prolonged standing and stress.*

Key words: *Covid-19 pandemic, Dental students, N95 face mask, and oxygen saturation*

Introduction :

Wearing protective equipment became a standard practice to prevent the spread of infection and transmission of disease responsible for coronavirus pandemic. The use of face masks conveys that noncompliance may result from a significant physiologic burden. Due to covid-19 pandemic, usage of medical N95 face masks became a must for healthcare providers.

N95 masks have relatively limited scientific data on their physiologic effects on the user. Having to wear N95 masks for long periods can be uncomfortable for dental professionals because it can trap heat and moisture beneath the mask, leading to exhaustion and fatigue due to difficulty and resistance to breathing while treating complicated cases. They are concerned that this will impact their productivity and level of performance. However, given that the usage of handpieces during routine surgical procedures generates aerosols, it is crucial to consider safety measures to maintain a healthy environment for both the students and the patients.

Recently, concerns have been raised about the safety of wearing face masks in community settings [1]. However, there continues to be controversy over nonmedical mask-wearing. Scheid et al. [2] reported that wearing masks even for an extended period does not produce any clinically relevant changes in circulating oxygen (O2) or carbon dioxide (CO2) concentrations and is not affecting the tidal volume or respiratory rate. However, they did report that wearing a mask causes a modest increase in breathing difficulty due to the mask material filtering particles in the air and moisture retained in the mask material. Furthermore, a study conducted on a convenience sample of 15 house staff physicians

Advances in Medical, Pharmaceutical and Dental Research Journal (AMPDR)- ISSN 2812-4898
http://dx.doi.org/10.21622/AMPDR.2022.02.1.015

without lung conditions and 15 veterans with severe chronic obstructive pulmonary disease (COPD) found no major changes in end-tidal carbon dioxide (ETCO2) or oxygen saturation (SpO2) of clinical significance at any time point in either group at rest [3]. These findings demonstrate that wearing a surgical mask has no effect on gas exchange, even in participants with severe lung impairment, and refute suggestions that wearing face masks in public places is dangerous.

On the other hand, ventilation, cardiopulmonary exercise capacity, and comfort were found in a further study [4] to be reduced by surgical masks and highly impaired by FFP2/N95 face masks in healthy individuals. These data can be used to recommend wearing face masks at work or during physical exercise. It was concluded that medical face masks have a marked negative impact on the cardiopulmonary capacity that significantly impairs strenuous physical and occupational activities. In a medical setting, Beder et al. [5] in 2020 conducted an observational study which was carried out amongst 52 surgeons wearing surgical masks, and found a decrease in arterial O2 saturation from approximately 98% before surgery to 96% after surgery which ranged from 1- 4 hours in length. In their study, they reported that pulse rates of the surgeons slightly increased and SPO2 decreased after the first hour which was attributed to either the facial mask or the operational stress. The decrease was more prominent in the surgeons aged over 35 years.

Prolonged use of N95 and surgical masks by healthcare professionals during Covid-19 has shown adverse effects such as headaches, rash, acne, skin breakdown, and impaired cognition [6 -10].

In a recent cross-sectional study looking at the effects of prolonged usage of N95 respirators and surgical masks in healthcare workers 488 experienced generalized nasal discomfort, 303 dry nose, 261 burning sensations in the nose, about 520 developed itchy nose, 560 acne in the face, 390 experienced redness on the face, 676 developed excessive sweating around the mouth, and 582 reported trouble breathing on exertion which is probably due to the mask tightness causing a hypoxic field that leads to physiological changes such as cardiorespiratory stress and metabolic shift [6]. Accordingly, frequent breaks improved hydration and rest skincare and newly designed more comfortable masks were recommended for future management of adverse effects related to prolonged mask use [3, 8]. In a recent study, Scarano et al. [11] reported that wearing a surgical mask for an extended period induces a reduction in circulating O2 concentrations without clinical relevance while an increase in heart rate, shortness of breath, lightheadedness, and headaches were recorded.

The effect of wearing an N95 face mask for a long time on dental students in clinical sessions has not been yet reported. Only one study by Gaikwad et al. [12] was published in 2021 in which a total of 90 exam-going dental students were included who were instructed to wear N95 masks for 4 hours. It was concluded that respiratory consequences due to the reduction in blood oxygen saturation level can be harmful. Blood oxygenation plays an essential role in providing the muscles, brain, and other organs the energy they need to function properly normal. The normal pulse oximeter readings in the healthy people range from 95% to 100%. Values under 90% are considered critical and indicate the need for supplemental oxygen. This condition is known as hypoxemia and its symptoms include severe breathing difficulty, increased heart rate, and chest tightness and pain. A pulse oximeter can quickly measure the oxygen saturation of hemoglobin accurately and in a reliable way. Pulse oximetry is a noninvasive method to measure blood oxygen saturation continuously. Pulse oximetry has a high sensitivity of 92% and a specificity of 90% when detecting hypoxia at a threshold of 92% oxygen saturation [13]. There is no set standard of oxygen saturation where hypoxemia occurs. The generally accepted standard is that a normal resting oxygen saturation of less than 95 is considered abnormal [13].

Aim of the work

This study aims to evaluate whether blood oxygen saturation level is affected by wearing an N95 mask among dental students for 3 hours. The primary focus of this study was to measure the student's oxygen saturation status and discomfort while they were engaged in their daily routine activities in the oral surgery clinics.

Materials and Methods

This prospective crossover observational study is conducted in an oral surgery clinical session over the period from May 2021 to June 2021. The study was approved by the local research ethics committee no. 2210221 following the declaration of Helsinki guidelines. 82 senior dental students were included in this study. Participation was voluntary and participants were prospectively recruited and approached to obtain informed verbal consent to participate in the study. Students eligible for inclusion were senior healthy students aged between 22-25 years, free from any medical condition that makes breathing difficult, and who wore the N95 mask continuously for three hours. Before enrollment the researchers excluded participants who interrupted the three-hour continuous period and subjects who had comorbid cardiac or respiratory conditions that could lead to dyspnea or hypoxia such as chronic respiratory diseases (COPD), chronic lung diseases, asthma, sleep apnea, anemia, hypertension, diabetes, smokers, and those who voluntarily quit the study to minimize variability.

The researchers provided participants with disposable sterile valveless N95 face masks and instructions on how to correctly wear the mask to ensure adequate nose and mouth coverage and to remove it with proper sanitization handling technique. Data concerning medical history were recorded by interviewing the participants preoperatively by two registered interns who were responsible for data collection. All participants had their peripheral oxygen saturation SpO2 measured using a portable pulse oximeter before wearing the mask baseline, 1 hour, 2 hours, and 3 hours after wearing the mask. At the end of the session, while they are performing the usual daily patient care including

simple and complicated teeth extraction, and a surgical dental procedure under staff supervision, blood oxygen saturation was measured using the same pulse oximeter with the probe applied to the second finger of the right hand. Participants were allowed to describe their feeling of discomfort if any throughout the study systolic (SBP) and diastolic (DBP) blood pressure and heart rate (HR) were also measured on the same day before and 3 hours after wearing the mask. Data obtained were compiled on a Microsoft office excel sheet and were subjected to statistical analysis, numerical data were explored for normality by checking the distribution of data and using normality tests of Kolmogorov, Smirnov, and Shapiro-Wilk tests. All data showed normal parametric distribution. Data were presented as mean, standard deviation (SD), and 95% confidence interval (95% CI) for the mean difference values. Paired t-test was used for comparisons related to heart rate and blood pressure. Repeated measures ANOVA test was used for comparisons related to oxygen saturation. Bonferroni's posthoc test was used for pairwise comparisons when the ANOVA test is significant. The level of significance was set at $p \leq 005$. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

Results

1) Baseline demographic data

The present study was conducted on 82 subjects: 23 females (28%) and 59 males (72%) and the mean and standard deviation values for age were 23.5 (±1.3) years old with a minimum of 22 and a maximum of 25 years old. The mean and standard deviation values for weight were 76.1 (±17.1) kilograms with a minimum of 44 and a maximum of 120 kilograms. The mean and standard deviation values for height were 1.71 (±0.09) meters with a minimum of 1.53 and a maximum of 1.88 meters.

2) Medical history and feeling of discomfort

All the participants included in this study were medically free. The follow-up rate was 100%. Most of the participants 84.15% (n= 69), apart from the physiologic and biological effect of the mask usage, reported some discomfort in terms of difficult breathing, quick exhaustion, tiredness, hotness, and slow performance not related to prolonged standing and stress.

3) Heart rate (beats/min.)

When preoperational and post-operational pulse rates were compared there was a statistically significant increase in mean heart rate after three hours (P-value = 0.001, Effect size = 0.311). Table I, Fig. 1.

Table I: Descriptive Statistics and Results of Paired t-test for Comparison between Heart Rate at Baseline and after Three Hours of Wearing a Mask

Baseline	3 hours	95% CI for the difference	*P*-value	*Effect size (d)*
Mean (SD)	Mean (SD)			
82.83 (10.85)	85.96 (8.64)	-4.85 - -1.41	0.001*	0.311

*: Significant at $P \leq 0.05$

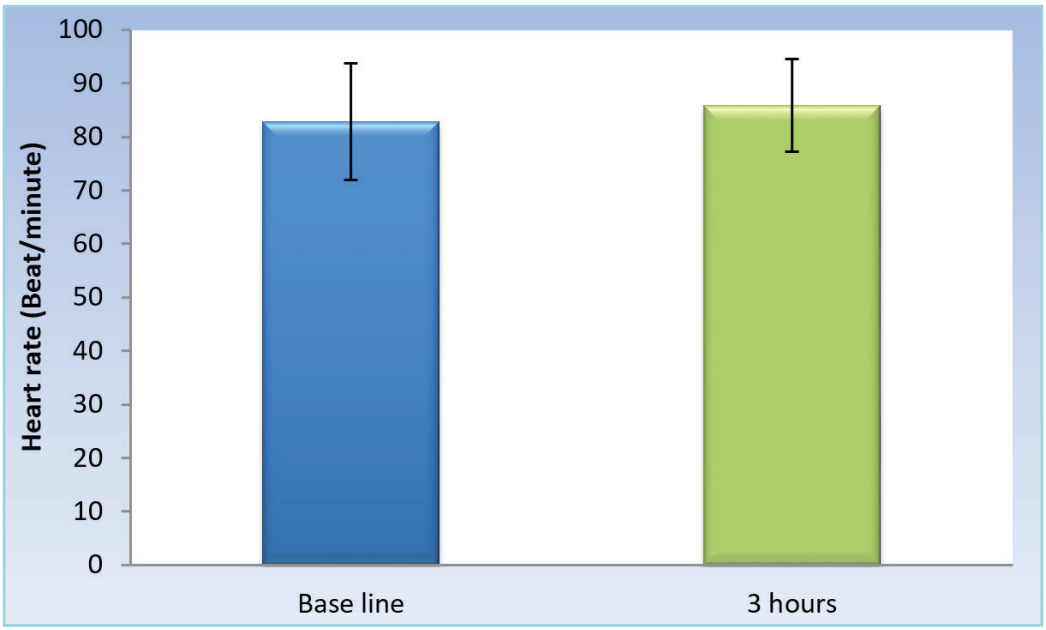

Fig. 1. Bar chart representing mean and standard deviation values for heart rate at baseline and after three hours.

Advances in Medical, Pharmaceutical and Dental Research Journal (AMPDR)- ISSN 2812-4898
http://dx.doi.org/10.21622/AMPDR.2022.02.1.015

4) Blood pressure (mmHg)

There was no statistically significant change in mean systolic/diastolic blood pressure after three hours (P-value = 0.630, Effect size = 0.066) and (P-value = 0.407, Effect size = 0.108), respectively. Table II, Fig. 2.

Table II: Descriptive Statistics and Results of Paired t-test for Comparison between Blood Pressure at Baseline and after Three Hours of Wearing a Mask

Blood pressure	Baseline Mean (SD)	3 hours Mean (SD)	95% CI for the difference	*P*-value	*Effect size (d)*
Systolic	116.43 (3.49)	116.2 (3.57)	-0.72 – 1.19	0.630	0.066
Diastolic	75.8 (3.86)	76.22 (3.84)	-1.4 – 0.57	0.407	0.108

**: Significant at P ≤ 0.05*

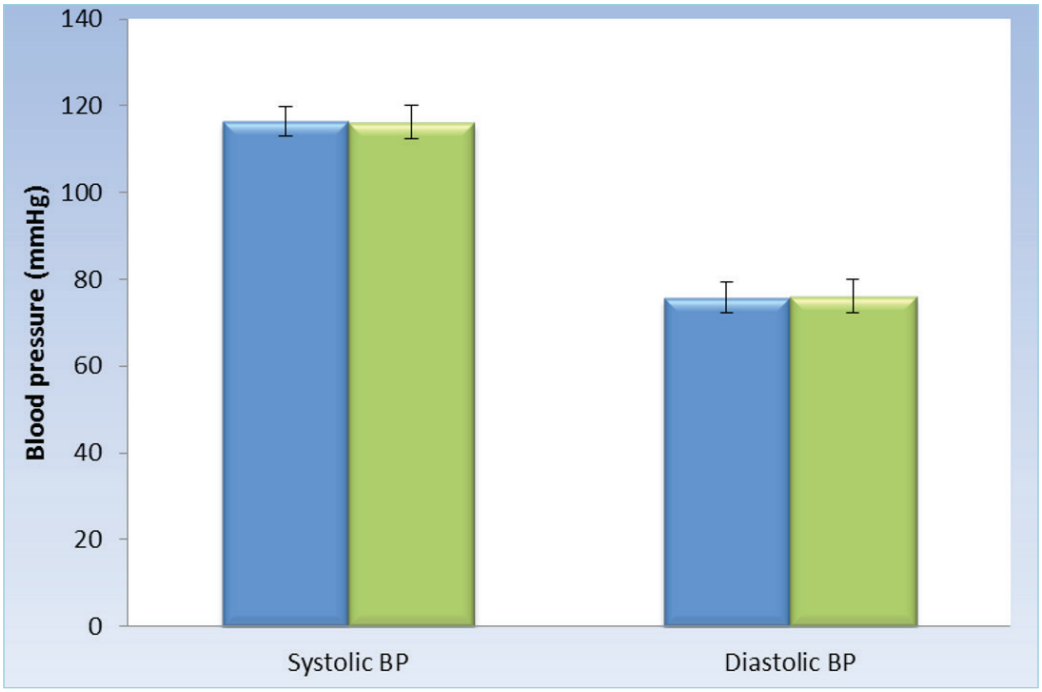

Fig. 2. Bar chart representing mean and standard deviation values for blood pressure at baseline and after three hours.

5) Oxygen saturation (%)

When the values for oxygen saturation of hemoglobin were compared, there was a statistically significant change in mean oxygen saturation by time (P-value <0.001, Effect size = 0.532). There were statistically significant differences only between pre-and post-operational values from baseline to 1 hour and from 1 to 2 hours. Pairwise comparisons using Bonferroni's posthoc test revealed a statistically significant decrease in mean oxygen saturation after one hour as well as from one to two hours followed by a non-statistically significant change in oxygen saturation from two to three hours Table III, Fig. 3. The mean oxygen saturation after three hours showed a statistically significant lower value compared with baseline measurement. Table IV shows a comparison of the mean change of SPO2 values of students before and after wearing the N95 mask at 1, 2 and 3 hours.

Table III: Descriptive Statistics and Results of Repeated Measures ANOVA Test for Comparison between Oxygen Saturation at Baseline, after One, Two as well as Three Hours of Wearing a Mask

Time	Mean (SD)	95% CI for the difference	*P*-value	*Effect size (Partial Eta Squared)*
Base line	98.61 (0.68) [A]	Base line vs. 1 h: -0.87 – -0.15	<0.001*	0.532
1 hour	98.1 (1.05) [B]	Baseline vs. 2 h: -1.81 – -0.82		
2 hours	97.29 (1.58) [C]	Baseline vs. 3 h: -2.08 – -1.07		
3 hours	97.04 (1.67) [C]	1 h vs. 2 h: -1.39 – -0.22		
		1 h vs. 3 h: -1.63 – -0.5		
		2 h vs. 3 h: -0.8 – 0.29		

**: Significant at P ≤ 0.05, Different superscripts are statistically significantly different*

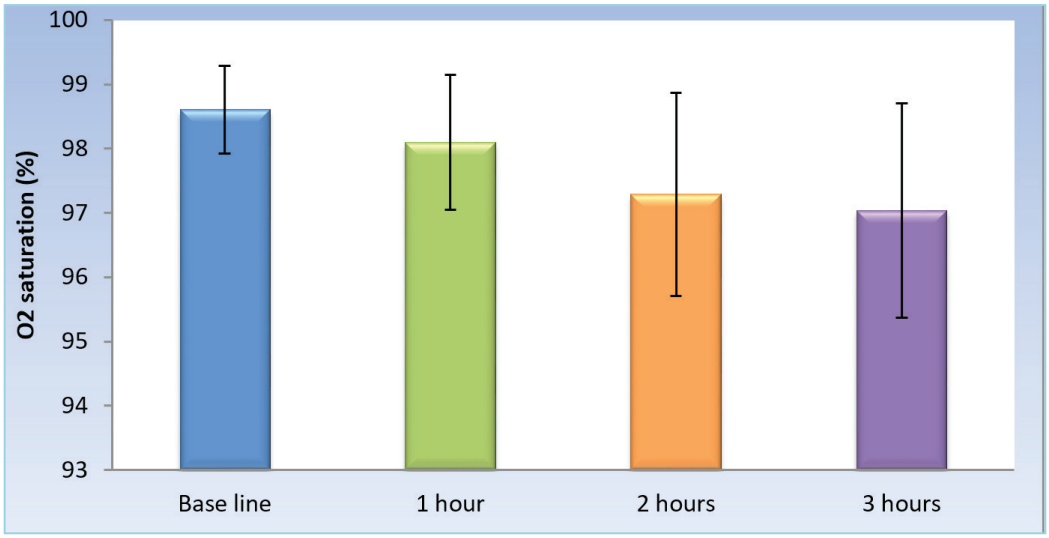

Fig. 3. Bar chart representing mean and standard deviation values for oxygen saturation at baseline, after one, two as well as three hours.

Advances in Medical, Pharmaceutical and Dental Research Journal (AMPDR)- ISSN 2812-4898
http://dx.doi.org/10.21622/AMPDR.2022.02.1.015

Table IV: Descriptive Statistics for the Amounts of Change in Oxygen Saturation after Wearing a Mask

Time	Mean change	95% CI for the change
Baseline vs. 1 h	-0.51	-0.87 – -0.15
Baseline vs. 2 h	-1.32	-1.81 – -0.82
Baseline vs. 3 h	-1.57	-2.08 – -1.07
1 h vs. 2 h	-0.81	-1.39 – -0.22
1 h vs. 3 h	-1.06	-1.63 – -0.5
2 h vs. 3 h	-0.26	-0.8 – 0.29

Discussion

There has been no controlled study concerning the effect of N95 masks on the level of blood oxygenation in students during their daily dental practice. Oral surgery providers operating face to face with the patients are at high risk of catching respiratory infections [14]. In this study, the researchers included only those working in an oral surgery session to grab those with a high level of physical activity while wearing the N95 mask. In this study, they measured the systolic and diastolic blood pressure and pulse rate before and 3 hours after wearing the mask. Results revealed a statistically significant increase in pulse rate (from 82.83 to 85.96 bpm) and unchanged blood pressure after 3 hours. Sometimes, the combination of low or unchanged blood pressure and high pulse rate signifies that the body is not getting enough oxygen, and heart rate can increase without any change in blood pressure.

As the heart beats became faster healthy blood vessels will dilate in size to allow increased blood flow, particularly in young healthy individuals which helps the blood pressure remain relatively stable [13].
Oxygen saturation SPO2 was measured by a pulse oximeter and showed a statistically significant decrease in the mean blood O2 saturation level of the student from 98.61% to 97.04%, after three hours, not pertinent to prolonged standing or stress as the discomfort occurred both in simple and long surgical dental procedures. These results coincide with further studies by Beder et al. [5] and Scarano et al. [11].

In this study, although there are minimal psychological impacts, however, some studies [15–18] showed theoretical evidence suggesting that there may be consequential impacts of mask-wearing on the basic psychological needs of competence autonomy, and relatedness. These psychological impacts may contribute to the controversy associated with wearing masks during the covid-19 pandemic [2]. Scarano et al. [19] in 2021 detailed that the dental specialists who wear individual defensive gear during oral medical procedures often experience exhaustion, actual distress, and conceivably even disintegration of careful judgment and execution, despite the presence of standard cooling in the working rooms. They added that an increase in airflow resistance, facial skin temperature, and physical discomfort during wearing masks can induce them to move it, with an increased risk of contagion. In this study, students were not allowed to wear the masks improperly or remove them from their faces.

Considering students' discomfort, it has been suggested that the facial temperature augmentation discomfort is also caused by exhaled CO2 levels under the protective facial mask, with sweating and hot flashes.

This could attribute to the difficult breathing, quick exhaustion, tiredness, hotness, and slow performance the students had experienced. Results of this study will help the researchers set standardized decisions and recommendations with the best evidence-based practice to assist in understanding human factors, recently acknowledged as an essential part of patient safety. In addition to developing guidelines on how long students should wear the N95 mask to promote their safety and maintain a safe clinical working environment by looking after their health and provide a safe practice and healthcare delivery processes. According to the findings, intermittent usage of the face mask (time off), work breaks and shifts, and rest are recommended to allow for proper breathing, improved hydration, and future management of adverse effects related to prolonged use of masks. The major limitation of this study was the inability to assess the effects of N95 mask usage over longer durations added that the sample size for the study was small, thus future research is encouraged with larger sample size. Furtherly, the researchers did not compare N95 mask effect to the regular surgical mask effect on the students as the researchers did not have a comparison arm.

Conclusion

This study revealed a decrease in the oxygen saturation (SpO2) and a slight increase in pulse rate compared to baseline values in all students three hours after wearing an N95 face mask. In addition, N95 mask induces discomfort in breathing, a decrease in physical performance, and increased fatigue not related to prolonged standing and stress.

Conflicts of interest: The authors declared no potential conflicts of interest.

Declarations of trial registration for observational studies and randomized controlled trials ethics. Approval: The study was approved by the local research ethics committee no. 2210221 following the declaration of Helsinki guidelines data availability all the data are available when needed.

Consent for publication: All the authors are pleased to submit the attached manuscript entitled blood oxygen level with long-term use of N95 face mask in dental practice during covid-19 pandemic to be considered for publication in (Advances in Medical, Pharmaceutical and Dental research)

Funding sources: None are declared
Acknowledgments: None are declared

References

[1] Chan NC, Li K, Hirsh J, "Peripheral Oxygen Saturation in Older Persons Wearing Nonmedical Face Masks in Community Settings," JAMA Research letters [Online]. October 30 2020. Available: https://jamanetwork.com/journals/jama/fullarticle/2772655.

[2] J. Scheid, S. Lupien, G. Ford, S. West, "Commentary Physiological and Psychological Impact of Face Mask Usage during the COVID-19 Pandemic," Int. J Environ Res Public Health, vol. 17 issue 18, p. 6655, Sep. 2020.

[3] R. Samannan, G. Holt, R. Candelario, M. Mirsaeidi, M. Campos, "Effect of Face Masks on Gas Exchange in Healthy Persons and Patients with Chronic Obstructive Pulmonary Disease" Ann Am Thorac Soc, vol. 18, issue 3, pp. 541-544, March 2021.

[4] S. Fikenzer, T. Uhe, D. Lavall, U. Rudolph, et al., "Effects of surgical and FFP2/N95 face masks on cardiopulmonary exercise capacity" Clin Res Cardiol, vol.102, issue 12, pp.1522-1530, Dec. 2020.

[5] A. Beder, Ü . Büyükkoçak, H. Sabuncuoğlu, ZA. Keskil, S. Keskil, "Preliminary report on surgical mask induced deoxygenation during major surgery," Neurocirugia (Astur), vol. 19, issue 2, pp. 121-126, April 2008.

[6] T. Rebmann, R. Carrico, J. Wang, "Physiologic and other effects and compliance with long-term respirator use among medical intensive care unit nurses" Am J Infect Control, vol. 41, issue 12, pp.1218-1223, Dec. 2013.

[7] World Health Organization, "Mask use in the context of COVID-19: interim guidance," Document [Online], December 1 2020. Available: https://apps.who.int/iris/handle/10665/337199. License: CC BY-NC-SA 3.0 IGO

[8] L. Matusiak, M. Szepietowska, P. Krajewski, et al., "Inconveniences due to the use of face masks during the COVID-19 pandemic: a survey study of 876 young people," Dermatol Ther, vol. 33, issue 4, p. e13567, July 2020.

[9] Ong, J, Bharatendu, C, Goh Y, Tang, J, Sooi, K, Tan Y L, Tan, B, Teoh, HL, Ong S T, Allen DM, SharmaV K, "Headaches Associated With Personal Protective Equipment - A Cross-Sectional Study Among Frontline Healthcare Workers During COVID-19," Headache, vol. 60, issue 5, pp. 864-877, May 2020.

[10] E. Rosner, "Adverse Effects of Prolonged Mask Use among Healthcare Professionals during COVID-19," J Infect Dis Epidemiol, vol. 6, issue 3, pp. 130-135, June 2020.

[11] A. Scarano, F. Inchingolo, B. Rapone, et al. "Protective Face Masks: Effect on the Oxygenation and Heart Rate Status of Oral Surgeons during Surgery," Int. J. Environ. Res. Public Health, vol.18, issue 5, pp. 2363-367, February 2021.

[12] R. Gaikwad, A. Banodkar, V. Nandgaonkar, L. Fernandes, et al., "Respiratory Consequences of N95 Mask during Covid-19 Pandemic- An Observational Study," International Journal of Health Sciences and Research, vol.11, issue 4, pp. 407-411, April 2021.

[13] W. Lee, K. Mayberry, R. Crapo, R. Jensen, "The accuracy of pulse oximetry in the emergency department," Am J Emerg Med, vol. 18, issue 4, pp. 427-31, Jul 2000.

[14] I. Bordea, E. Xhajanka, S. Candrea, S. Bran, et al., "Coronavirus (SARS-CoV-2) Pandemic: Future Challenges for Dental Practitioners," Microorganisms, vol. 8, issue 11, pp. 704- 1708. October 2020.

[15] E. Lim, R. Seet, K. Lee, et al., "Headaches and the N95 face-mask amongst healthcare providers," Acta Neurol Scand, vol. 113, issue 3, pp. 199-202, March 2006.

[16] L. Nickell, E. Crighton, C. Tracy, et al., "Psychosocial effects of SARS on hospital staff: a survey of a large tertiary care institution," CMAJ, vol. 170, issue 5, pp. 793-798, March 2004.

[17] J. Zhu, S. Lee, D. Wang, H. Lee, "Effects of long-duration wearing of N95 respirator and surgical facemask: a pilot study. g-duration wearing of N95 respirator and surgical facemask: a pilot study," J Lung Pulm Respir Res, vol. 1, issue 4, pp. 97-100, November 2014.

[18] Y. Li, H. Tokura, et al., "Effects of wearing N95 and surgical facemasks on heart rate, thermal stress, and subjective sensations," Int Arch Occup Environ Health, vol. 76, issue 6, pp. 501-509, Jul 2005.

[19] A. Scarano, F. Inchingolo, F. Lorusso, "Facial Skin Temperature and Discomfort When Wearing Protective Face Masks: Thermal Infrared Imaging Evaluation and Hands Moving the Mask," Int J Environ Res Public Health. Vol. 17, issue 13, p. 4624, June 2020.