International Egyptian Journal of Nursing Sciences and Research (IEJNSR)

Original Article

Received 27/03/2022
Accepted 16/04/2022
Published 01/07/2022

Effect of Wearing a Face Mask on Oxygen Saturation among Hemodialysis Patients Versus Healthy Staff Members

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ABSTRACT

Background: COVID-19 represents a major threat to hemodialysis health life, due to their low immunity, it is essential to wear a face mask to protect them against the outbreak of the COVID-19 pandemic. **Aim**: To evaluate the effect of wearing a face mask on oxygen saturation among hemodialysis patients versus healthy staff members.

Methods: Research design: a quasi-experimental research design **Setting:** dialysis units at Mansoura University and New General Mansoura hospital. **Subjects:** A purposive sample with a total of 190 patients was classified into two equal groups, entitled hemodialysis patients group and healthy staff members group, each group involved 95 participants. **Tools**: Tool I: A structured interview oxygen saturation assessment sheet. Tool II: Face Mask Perceptions Scale. **Results**: no significant difference in oxygen saturation during wearing masks compared to non-wearing masks in both groups. **Conclusion**: wearing different types of protective face masks had no effect on oxygen saturation among hemodialysis patients and healthy staff members. **Recommendations:** All hemodialysis patients and healthy staff members should wear a face mask in hemodialysis units or the public area as protection against COVID-19 infection.

Keywords: Face mask, Hemodialysis patients, Oxygen saturation.

1. Introduction:

COVID-19 represents a major threat to human life, and health, particularly in underlying medical conditions such as kidney failure, who are weaker and more susceptible to infection than the general people. It is vital to provide these patients with better care (Zhang et al., 2020). Dialysis patients should wear masks when traveling to dialysis and in waiting areas before dialysis treatment and assessment. As masks are provided for patients for travel and waiting rooms, these logically should also be worn within the unit for treatment, if tolerated (British Renal Society, 2022).

Hemodialysis patients are especially vulnerable to COVID-19 because of their significant comorbidities, impaired immune function, and frequent face-to-face interactions as part of their life-sustaining therapy. Consistent with this premise, dialysis units are prone to COVID-19 outbreaks, and end-stage kidney disease patients with COVID-19 experience higher morbidity and mortality compared to other populations (Qirjazi et al., 2021)

Basic cloth masks, surgical masks, N95 respirators, filtering facepiece respirators, P100 respirators/gas masks, self-contained respirators, full-face respirators, full-length facepieces, and KN95 respirators are examples of several types of masks. Basic and surgical masks have been approved for public use by the WHO, while N95 respirators are recommended for use in hospital environments. Because N95 mask-wearing in ESRD patients was associated with a significant increase in respiratory adverse effects during hemodialysis (HD), these possible negative effects should be taken into account when developing recommendations for N95 mask use in these patients (Who. int. 2022).

Oxygen saturation is dependent upon, oxygen availability, Gas exchange in the lungs, the ability of oxygen to reach the alveoli and diffuse through the walls of the alveoli to reach the red blood cells, the concentration of hemoglobin in red blood cells, the affinity of hemoglobin for oxygen. These conditions include chronic obstructive pulmonary disease (COPD), asthma, pneumonia, lung cancer, anemia, heart failure, heart attack, and other cardiopulmonary disorders (Dutta, 2022).

Renal anemia is a common complication in patients with advanced chronic kidney disease (CKD), including hemodialysis (HD) patients. Under a severe anemic status caused by the progression of renal anemia, it is largely responsible for the significant detrimental effects of CKD including decreases in exercise capacity, immune response, cognitive function, and nutrition, and increases in depression, cardiac dysfunction, morbidity, and mortality so that patients with CKD who are referred for dialysis predisposing to covid 19 (Ookawara et al., 2020)

Shein et al., (2021) concluded in their healthy study sample that,

facemasks did not impair oxygenation or ventilation among adults at rest or during physical activity. No episodes of hypoxemia or hypercarbia occurred with either cloth or surgical masks, both at rest and while walking briskly.

Significance of the study

WHO Health Emergency Dashboard (2022) estimated that, Globally, in April 2022, there have been 494,587,638 confirmed cases of COVID-19, including 6,170,283 deaths, and a total of 11,250,782,214 vaccine doses have been administered.

Since the start of dialysis, hypoxemia during hemodialysis has been identified. Nearly one-fifth of patients have hypoxemia and a significant increase in respiratory rate as well as the incidence of chest discomfort and respiratory distress. With no end in sight for the pandemic, public health experts have asked for widespread preventive behavior; however, many refuse to use masks, posing a significant risk in the COVID-19 Pandemic (Meyring-Wösten et al., 2016 & Howard, 2021).

Aim of the study: To evaluate the effect of wearing a face mask on oxygen saturation among hemodialysis patients versus healthy staff members.

2. Hypothesis

There will be no effect of wearing a face mask on oxygen saturation among hemodialysis patients and healthy staff members**.**

3. Methodology

Materials

Research design: A quasi-experimental research design was used in this study.

Setting: This study was carried out in dialysis units at Mansoura University hospital and New General Mansoura hospital.

Concerning New General Mansoura hospital, the hemodialysis unit consists of six rooms enumerated from one to six with 42 machines ; Room number 1, 2, and 6 are used for positive hepatitis C patients, room number 4 is used for positive hepatitis B patients, but room number 3 and 5 are used for negative patients.

Concerning Mansoura University hospital, the hemodialysis unit consists of four rooms enumerated from one to four with 26 machines. Room numbers 1& 2 are used for positive hepatitis C patients, room number 3 is used for positive hepatitis B patients, but room number 4 was used for negative patients.

Subjects:

The sample size was calculated using the G power program using the following data: effect size 0.3, α error prop 0.05, two tail, and power (1-β err prop) 99 % using an independent t-test to detect the difference between two dependent means. The sample size is 190 participants.

A purposive sample of healthy staff members & patients diagnosed with chronic renal failure on regular

hemodialysis of both sexes with a total of 190 participants classified into two equal groups entitled hemodialysis patients group and healthy staff members group, each group involved 95 participants. The hemodialysis patients' group was distributed as follows (43 hemodialysis patients from Mansoura University hospital and 52 hemodialysis patients from New General Mansoura hospital, while the healthy staff members group, involved (nurses, physicians, and workers who were distributed as follows, 38 from Mansoura University hospital and 57 New General Mansoura hospital).

Exclusion criteria:

Personnel with psychiatric disorders, respiratory diseases, recent cardiothoracic, maxillo- facial surgery, and morbid obesity.

Tools for data collection: Two tools were used to achieve the aim of this study:

Tool I: A structured interview oxygen saturation assessment sheet.

This tool was developed by the researchers based on a literature review to assess oxygen saturation, and consisted of 3 parts:

Part 1: Demographic characteristics data such as age, gender, residence, marital status, educational level, occupation, and financial status.

Part 2: health history: this part included (12 items), such as comorbidities, smoking habits, obesity, anthropometric measurements such as body weight and height, body mass index, history of COVID- 19 infection, and types of face masks.

Part 3: Physiological parameters: included 3 different physiological parameters as follows hemoglobin level, blood pressure, and oxygen saturation, respiratory and heart rate.

Tool II: Face Mask Perceptions Scale (FMPS): the structured self-reported FMPS adopted from (Howard, 2020): consisted of 16 items of which each response is scored as agree and disagree.

Validity and reliability

- Content validity and reliability of the tools were checked by seven experts from the medical-surgical nursing specialty and a nephrology specialist. Modifications were done based on their recommendations.
- The internal consistency of the tool was conducted by Chronbach alpha test which showed 0.894

- The validity of the tools was carried out through a panel of experts from medical and nursing staff.
- Tool **II** reliability was estimated using Chronbach´s alpha test to calculate the internal consistency. It was founded as follows, Face Mask Perceptions Scale (FMPS) ($\alpha = 0.835$). Also, reliability was calculated using the **test-retest** method by using SPSS program version 25 which showed that reliability for Face Mask Perceptions Scale (FMPS) was ($r = 0.826$).

N.B Chronbach´s alpha is an international measure of reliability. Its maximum value is 1.0 which indicates the highest reliability, and the minimum accepted value is 0 .65

below this value indicates an unreliable tool.

Ethical consideration

- Oral consent was obtained from all participants either hemodialysis patients or healthy staff after illustrating the aim of the study.
- All participant's data was considered a secret with complete confidentiality.
- The participants were informed that they have the right to withdraw at any time during the study period.

Data collection

Data collection involved nine months through three phases as follows:

Preparation phase:

- This phase started from January 2021 to March 2021.
- Official permission was obtained from the general director of Mansoura University hospital and New General Mansoura hospital after explaining the aim of the study to obtain permission for data collection.

Tools development

- **Tool I** was developed by the researchers based on a recent literature review (Hofmeyr, 2020, Herselman et al., 2021, Williams et al., 2021, Bibiano-Guillen et al., 2021, Malay, 2021& Setia et al., 2021).
- **Tool II** was adopted by the researchers without change in its content based on a recent literature review (Howard, 2020).
- Tools were prepared and translated from English to the Arabic language.
- A pulse oximeter (model: Granzia finger-pulse oximeter, pulsox 301, Italy) was prepared to measure Oxygen saturation.
- Easy Mate GCHb Meter device (model: ET-331) was prepared to measure hemoglobin levels.
- A Mercury sphygmomanometer was used to measure blood pressure.
- Four packets with a total of 200 surgical face masks were prepared.

Pilot study

- It was conducted on 10% of the subjects (190 participants) as the researchers randomly selected 9 hemodialysis patients and 9 healthy members.
- It was done to check the feasibility & applicability of the tools to help the researcher to determine the needed time for answering all the questions and they were excluded from the total statistical analysis score; the needed correction & modifications were made, and the patients included in the pilot study were excluded from the study subjects.

Intervention phase:

- This phase started from April 2021 to June 2021.
- During this phase, the researchers used tool 1 to collect demographic data and health history as follows:
- Oral consent was obtained from all participants either hemodialysis patients or healthy staff members after illustrating the aim of the study.

- Anthropometric measurements such as body weight, height,and body mass index was assessed for both groups using the following formula
- Body mass index for both groups was calculated by having the participant′ height that was measured and recorded in meters. The participant′ body weight was measured and recorded in kilograms. Then the researcher divided the post-dialysis body weight (Kg) / height (m^2). [Weight (kg) /height^2 (m^2)] **(World Health Organization, 2022)**.

- According to (**World Health Organization, 2020)** anthropometric measurements include three elements as follows patient (weight –height &body mass index "BMI"). Standards classify BMI into several categories: below 18.5 /underweight, 18.5-24.9 / normal, 25-29.9 / overweight, 30-39.9 / obese, and above 40 / very obese.
- Tool 1 part 3 to measure oxygen assessment measurement that included 3 different parameters as follows: Hemoglobin level, blood pressure, and SpO2, respiratory rate & heart rate.

- The researchers used the pulse oximeter device named "Pulse oximeter (model: Granzia finger-pulse oximeter, pulsox 301, Italy) by putting it on patients' fingers to measure participants' oxygen saturation, at the same time the researchers calculate respiratory rate during the full minute and record it to avoid control on respiratory mechanism.
- Radial pulse was calculated to measure heart rate and recorded on the sheet.

- Hemoglobin level measurement was done through the device named "Easy Mate GCHb Meter device (model: ET-331)". This device measures hemoglobin levels using a specific strip, the researchers use an Accua check pen to stick the participants' finger to get blood drops which will be used with the strip to measure hemoglobin, and then it was recorded on the sheet.

- After obtaining the needed data, the researchers ask the participants to wear the mask for 30 minutes then the researcher re-measures the oxygen saturation, heart rate, and respiratory rate and recorded it.

- The researchers gave the questionnaire sheet to the participants (Tool II) and asked them to write their responses, for those who can't read and write; the researchers read the sheet to them and wrote their exact responses. The time consumed to fill is half an hour. For measuring O2 saturation in hemodialysis patients and healthy staff members, study participants have taken it for the first time by wearing a face mask minimum of one hour and without a face mask for a minimum of 15 minutes.

Evaluation phase

This phase focused on evaluating the effect of wearing a face mask on oxygen saturation among HD patients and healthy staff members, (**Tool I & Tool II)** and started from July 2021 till the end of September 2021.

Statistical analysis:

All statistical tests were conducted using SPSS for windows version 25.0 (SPSS, Chicago, IL). Continuous data were normally distributed and were expressed in mean ±standard deviation (SD). Categorical data were expressed in frequency and percentage. The comparisons were determined using Student's t-test for two different variables with continuous data and paired t-test for two paired variables with continuous data. Pearson correlation was used to check the correlation between variables, where $r = 1$ means a perfect positive correlation and $r = -1$ means a perfect negative correlation. Statistical significance was set at $p<0.05$.

4. Results

Figure 1: Frequency distribution of demographic characteristics of the studied sample (N= 190)

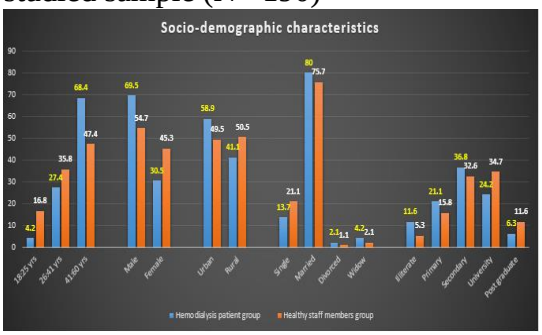

Figure -1- shows that the highest percentage of HD patients and healthy staff members' age ranged between 41: and 60 years, male, and married. Regarding residence three-fifths of the HD, the group lives in the urban area and half of the healthy staff members group live in rural areas. Regarding Educational level, the highest percentage of HD patients were secondary educated and the highest percentage of healthy staff members were university educated.

Table 2: Frequency distribution of studied sample according to health history (N= 190)

Items	Hemodialysis patients group (n= 95)		Healthy staff members group (n= 95	
	No	%	No	%
Co-morbidity				
▪ **Yes**	59	62.1	40	42.1
▪ **No**	36	37.9	55	57.9
Associated disease(N=59 & 40)				
▪ **DM**	10	16.9	8	20
▪ **HTN**	36	61	26	65
▪ **Intradialytic hypotension**	8	13.6	3	7.5
▪ **Liver diseases**	3	5.1	1	2.5
▪ **Others**	2	3.4	2	5
Smoking habit				
▪ **Yes**	13	13.7	16	16.8
▪ **No**	82	86.3	79	83.2
Obesity				
▪ **Yes**	31	32.6	28	29.5
▪ **No**	64	67.4	67	70.5
Body mass index				
▪ **Normal weight**	30	31.6	39	41.1
▪ **Overweight**	24	25.3	25	26.3
▪ **Obese**	41	43.2	31	32.6
History of COVID -19 infection				
• **Yes**	17	17.9	26	27.4
• **No**	78	82.1	69	72.6
Last COVID-19 infection (n=17 & 26)				
• < 3 months	14	82.4	16	61.5
• 4:6 months	3	17.6	6	23.1
• 7:9 months	0	0	3	11.5
• 10:12 months	0	0	1	3.8

Table (2) reflects that highest percentage of the HD patients group suffered from co-morbid disease, and two-fifths of the healthy staff members group was suffered from a co-morbid disease. Also, the highest percentage of both groups were hypertensive.Regarding obesity,the highest percentage of HD patients and healthy staff members were not obese.Regarding history of COVID-19 infection,only less than one-fifth of the hemodialysis group and slightly more than one-quarter of the healthy group had a history of COVID-19 infection.

Table 3: Medical parameters data of the hemodialysis patients & healthy staff members staff (N=190).

Items	Hemodialysis patients group (n= 95)	Healthy staff members group (n= 95	Significance
	Median (IQR)	Median (IQR)	
Hb	8.639 ±1.052	12.523 ±1.584	t= -19.897 , p=0.000**
SBP (IQR)	130 (30)	130 (20)	Z=-1.193 , p=0.233
DBP (IQR)	80 (10)	80 (10)	Z= -0.699, p=0.484
SPO2 without wearing mask (IQR)	97 (3)	98 (2)	Z= -3.054 , p=0.002*
SPO2 during wearing mask (IQR)	96 (4)	97 (2)	Z= -2.964 , p=0.003*
R.R with out wearing mask (IQR)	20 (4)	20 (6)	Z=-0.841 , p=0.400
R.R during wearing mask (IQR)	22 (7)	21 (6)	t=-0.119, p=0.905
H.R without wearing mask	83.136 ±16.884	85.357 ±15.524	t= -0.944 , p=0.346
H.R during mask	83.652 ±17.354	86.957± 16.668	t=-1.339 , p=0.182

Table (3) clarifies that there is a significant difference between the hemodialysis patients group & health staff members groups concerning hemoglobin levels and oxygen saturation (SPO2) without wearing a mask & during wearing the mask.

Table 4: Effect of wearing the mask on O2 saturation & vital signs for the studied sample

Variables	Hemodialysis patients group Median (IQR)		Healthy staff members group Median (IQR)	
	During mask-wearing	After mask removal	During mask-wearing	After mask removal
O2 sat.	96 (4)	97 (3)	97 (2)	98 (2)
Sig.	Z= -3.432 , *p*=0.001*		Z= -2.708 , *p*=0.007*	
RR	22 (7)	20 (4)	21 (6)	20 (6)
Sig.	Z= -4.701 , *p*=0.000**		Z= -4.67 , *p*=0.000**	
HR	83.652 (17.354)	83.136 (16.884)	86.957 (16.668)	85.357 (15.524)
Sig.	t= -0.523 , *p*=0.602		t= -1.758 , *p*=0.082	

Table (4) shows that there is a statistically significant but clinically non-significant difference in oxygen saturation during wearing masks compared to non-wearing masks in both groups. Moreover, there is a statistically significant difference in respiratory rate during wearing masks compared to non-wearing masks in both groups.

Table 5 Relation between oxygen saturation and patient history

Variables	Hemodialysis patients group Mean rank		Sig.	Healthy staff members group Mean rank		Sig.
	SPO2 without mask	SPO2 with mask +ve ranks		SPO2 without mask	SPO2 with mask +ve ranks	
Co-morbidity						
- **Yes**	36.27	36.61	Z= -2.529 , *p*=0.011*	20	45	Z= -3.665 , *p*=0.000*
- **No**	25.95	36.13	Z= -3.665 , =0.000**	24	48	Z= -2.529 , *p*=0.011*
Types of mask						
N95	1	3	Z= -1.461 , *p*=0.144	0	0	Z= … , p=…
Surgical	50.90	70	Z= -3.224, *p*=0.001*	13	28	Z= -1.67 , p=0.09
FFP2	6.90	16	Z= -2.833 , *p*=0.005*	5	2	Z= -2.833 , p=0.005*
Cloth	5.50	4	Z=-1.106 , *p*=0.915	2	4	Z= -1.10 , p=0.91

Table (5) shows that there is a significant difference in oxygen saturation among two groups with comorbidity during wearing masks compared to non-wearing masks. In addition, concerning types of masks, there is a significant difference in oxygen saturation among hemodialysis patients group whom wearing surgical masks compared to non-wearing masks.

Table 6: Correlation between different variables for the studied sample

Group	Variables	R	*P*
Hemodialysis patients group	Hemoglobin & SPO2 without wearing a mask	0.051	0.624
	Hemoglobin & SPO2 with mask	0.070	0.501
	SPO2 with mask & RR without wearing a mask	0.204	0.047*
	SPO2 & RR with wearing mask	0.136	0.189
	SPO2 with mask & HR without the mask	0.090	0.383
	SPO2 with mask & HR with wearing mask	-0.024	0.814
Healthy staff members group	Hemoglobin & SPO2 without wearing a mask	-0.203	0.048*
	Hemoglobin & SPO2 with wearing mask	-0.188	0.068
	SPO2 with		

	mask & RR without wearing a mask	0.150	0.148
	SPO2 & RR with wearing mask	0.157	0.128
	SPO2 with mask & HR without wearing the mask	0.117	0.258
	SPO2 & HR with wearing mask	0.106	0.307

Table (6) reveals that, concerning the hemodialysis group, there is a significant correlation between oxygen saturation and respiratory rate without wearing a mask. Concerning the health staff members group, there is a significant correlation between oxygen saturation without wearing a mask and hemoglobin level.

6. Discussion

Part (I): Socio-demographic characteristics, and health history of studied patients.

According to the findings of the current study, two-thirds of hemodialysis patients were between the ages of 41 and 60, which may explain why hemodialysis patients are mostly elderly also 53% of the studied patients were men. This outcome was in line with (Goicoechea et al., 2020). Furthermore, nearly two-thirds of the hemodialysis patients were men. This is because women have a lower prevalence of HD than men (Meyring-Wosten et al., 2016).

Concerning associated diseases among hemodialysis patients, the current study revealed that three-fifths of the hemodialysis group had hypertension. This could be because HD patients are older, have more problems, and have a worse immune system than healthy staff members group. This observation is in line with others (Zhang et al., 2020).

Part (II): The duration of wearing a face mask during the day.

In concerns to daytime mask wear, the current study's findings suggested that less than a quarter of the hemodialysis group reported wearing a mask for 2:3 hours per day, whereas one in five reported using a mask for 2:3 hours per day during hemodialysis. The second patient wears one mask every hour or less. In contrast, Dattel, O'Toole, Lopez, & Byrnes, (2020) discovered that more than half of the study participants wore masks for two hours. This, researchers' opinion, may be attributed to the fact that many patients remark that masks irritate and annoy them.

Furthermore, surgical masks were used by slightly more than two-thirds of those in the hemodialysis group, while surgical masks were utilized by the majority of those in the healthy group. Surgical masks are less expensive and more readily available than N95 masks. This finding is in line with the findings of Dattel, O'Toole, Lopez, & Byrnes, (2020) who found that more than half of the study participants used surgical masks.

Part (III): Difference in medical data between hemodialysis patients group and healthy members group.

According to the findings of this study, the majority of the patients in this study had anemia. This finding is in line with the findings of Zhang et al., 2020, who found that the HD patient group analyzed had more severe anemia and coagulation problems than the other groups. Renal failure and dialysis are induced as a result of insufficient iron intake, excessive blood loss, and insufficient erythropoietin secretion.

Part (IV): Effect of wearing the mask on oxygen saturation & vital signs.

When wearing a mask versus not wearing a mask, the current study found a statistically significant change in oxygen saturation between the two groups. Also, there is a statistically significant difference in respiratory rate during wearing masks compared to non-wearing masks in both groups. Finally, there is no statistically significant difference in heart rate during wearing masks compared to non-wearing masks in both groups. This is supported by the findings of Tong, et al., 2015, who found that wearing an N95 mask for four hours during hemodialysis lowered PaO2.

Furthermore, when wearing a mask versus not wearing a mask, there was no significant variation in heart rate between the two groups. The current findings were in line with those of Akgül, Ozcan, Uzun, Gurses, & Baydil, 2021 who found no significant changes in pulse rate or blood pressure.

Finally, while wearing a mask versus not wearing a mask, there was a statistically significant difference in respiratory rate between the two groups. This was supported by the findings of Beder, Büyükkoçak, Sabuncuolu, Keskil, & Keskil, (2008) who found that one hour after wearing a surgical mask, pulse rate increased and SaO2 decreased.

In researchers' opinion, the researchers believe this is because the mask makes respiratory rate increase due to difficulty in breathing that may occur during wearing the mask, also more carbon dioxide is inhaled while exhaling into the mask because the exhaled carbon dioxide is trapped between the face and the mask, resulting in an increased respiratory rate. Furthermore, N95 masks obstruct breathing and gas exchange (arterial partial pressure of oxygen) and harm breathing in persons who receive hemodialysis regularly. For another point, oxygen saturation was improved after the removal of the mask due to the enhanced respiratory rate which enables more gas exchange. The heart rate seems to not be affected by wearing the mask.

Part (V): Relation between oxygen saturation and selected patient's history items.

There was a significant link between blood oxygen saturation and co-morbidities in the hemodialysis group and the healthy group, according to the current study. The work of Rangin G., (2020) was in great agreement with the last mentioned findings and found a significant positive relation between

blood oxygen saturation and co-morbidities. While these findings disagreed with those of Akgül, Ozcan, Uzun, Gurses, & Baydil, (2021), who discovered that variations in oxygen saturation were unrelated to age, gender, diabetes, or the presence of cardiovascular disease.

Furthermore, there was a significant link between blood oxygen saturation and the type of mask worn in both groups, according to the current findings. These results may be occurred due to that wearing a mask can increase the risk of co-morbidity for both hemodialysis patients and healthy groups, also different types of masks may have the same effects on the studied groups. The findings of Dattel, O'Toole, Lopez, & Byrnes, (2020) disagreed with the last mentioned findings as they showed that there were no significant differences between mask types and oxygen saturation.

Part (VI): Correlation between different variables.

The results of this study demonstrated that whether or not a mask was used, there was no significant link between oxygen saturation and hemoglobin levels in the hemodialysis group. In our point of view, it is attributable to the fact that the majority of hemodialysis patients are anemic. This contradicted the findings of Tortonese et al., (2020) who found a strong link between oxygen saturation and hemoglobin levels.

Furthermore, the current study revealed that wearing a mask in hemodialysis patients has a significant positive correlation with respiratory rate, while there was no significant link between blood oxygen saturation and respiratory rate in the other cases. This finding was in disagreement with research by Kuehn, (2020), who found no significant link between oxygen saturation, respiratory rate, and heart rate.

The current study found a strong negative correlation between oxygen saturation and hemoglobin levels in the healthy group when they were not wearing a mask. Furthermore, during mask use, there was no association between blood oxygen saturation and heart rate. This finding was supported by Scarano, Inchingolo, Rapone, Festa, Tari & Lorusso, (2021), who found a significant correlation between oxygen saturation and hemoglobin levels, as well as heart rate, when wearing or not wearing a mask.

In researchers' opinion, could be attributable to different causes of hypoxia such as anemia and heart disease, and no evidence wearing a mask promotes hypoxia. An increase in heart rate is caused by a reduction in the concentration of functional hemoglobin or the number of red blood cells in anemic hypoxia.

7. Conclusion

Based on the study findings, it was concluded that wearing different types of protective face masks had no effect on oxygen saturation among hemodialysis patients and healthy staff members.

8. Recommendations

- All hemodialysis patients and healthy staff members should

wear face masks in hemodialysis units or the public area as protection against COVID-19 infection.

- Future research should be applied to investigate factors that influence hemodialysis and healthy's willingness to wear face masks.

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