N95 masks: skin changes in health professionals in northern Brazil

Máscaras N95: alterações de pele em profissionais de saúde do norte brasileiro

Mascarillas N95: alteraciones en la piel de profesionales de salud en el norte de Brasil

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Abstract

Objective: To identify the factors associated with N95 mask use related to skin changes among health professionals in northern Brazil during the COVID-19 pandemic.

Methods: This is a multicenter study carried out in northern Brazil, from October to December 2020, with 1,684 health professionals who worked in health care during the COVID-19 pandemic. Participants were invited via social media and the information collected electronically was stored on the Survey Monkey platform. Descriptive statistics were used to characterize the sample, association tests (chi-square), with statistical significance level at $p < 0.05$. Factors associated with N95 mask ruse elated to skin changes were determined by Binary Logistic Regression, significance level of 5% ($\alpha = 0.05$).

Results: Male health professionals were 1.708 more likely to have skin changes. Other factors such as the N95 mask change period, having worked in a COVID-19 field hospital, intensive care, urgency and emergency and having received some training or course on COVID-19 were considered protective against the development of skin changes, while the main reasons for changing the N95 mask were humidity, loss of seal, contamination, damage (tear).

Conclusion: We concluded that male health professionals were more likely to have skin changes related to N95 mask use. The protective factors were highlighted and it is relevant to carry out intervention studies in order to explore measures to prevent these types of injuries.

Resumo

Objetivo: Identificar os fatores associados ao uso de máscara N95 relacionados a alterações de pele entre profissionais de saúde do Norte do Brasil durante a pandemia de COVID-19.

Métodos: Estudo multicêntrico realizado na região Norte do Brasil no período de outubro a dezembro de 2020, com 1.684 profissionais de saúde que atuaram na assistência à saúde durante a pandemia da COVID-19. Os participantes foram convidados via mídias sociais e as informações coletadas eletronicamente foram armazenadas na plataforma Survey Monkey. Foi usada estatística descritiva para caracterização da amostra, testes de associação (Qui-quadrado), com nível de significância estatística em $p < 0,05$. Os fatores associados ao uso de máscara N95 relacionados a alterações de pele foram determinados por Regressão Logística Binária, nível de significância de 5% ($\alpha = 0,05$).

Resultados: Profissionais de saúde do sexo masculino apresentaram 1,708 mais chances de ter alterações de pele. Outros fatores como, o período de troca de máscara N95, ter atuado em hospital de campanha para COVID-19, terapia intensiva, urgência e emergência e ter recebido alguma capacitação ou curso sobre

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o COVID-19 foram considerados protetores ao desenvolvimento de alterações de pele, enquanto os principais motivos de troca de máscara N95 foram a umidade, perda de vedação, contaminação, danificação (rasgo).

Conclusão: Concluiu-se que profissionais de saúde do sexo masculino apresentaram mais chances de ter alterações de pele relacionadas ao uso de máscaras N95. Destacaram-se os fatores protetores e torna-se relevante a realização de estudos de intervenção a fim explorar medidas para prevenção destes tipos de lesões.

Resumen

Objetivo: Identificar los factores asociados al uso de la mascarilla N95 relacionados con las alteraciones en la piel entre profesionales de salud del norte de Brasil durante la pandemia de COVID-19.

Métodos: Estudio multicéntrico realizado en la región Norte de Brasil, en el período de octubre a diciembre de 2020, con 1.684 profesionales de salud que actuaron en la asistencia a la salud durante la pandemia de COVID-19. Se convocó a los participantes a través de las redes sociales y la información recopilada electrónicamente fue guardada en la plataforma Survey Monkey. Se utilizó la estadística descriptiva para la caracterización de la muestra, pruebas de asociación (Ji-cuadrado), con un nivel de significación estadística de $p < 0,05$. Los factores asociados al uso de la mascarilla N95 relacionados con alteraciones en la piel fueron determinados por regresión logística binaria, nivel de significación del 5 % ($\alpha = 0,05$).

Resultados: Profesionales de salud de sexo masculino tuvieron 1,708 más posibilidades de presentar alteraciones en la piel. Otros factores como el intervalo de tiempo entre los cambios de mascarillas N95, haber trabajado en hospitales de campaña para COVID-19, cuidados intensivos, urgencias y emergencias y haber realizado alguna capacitación o curso sobre COVID-19 fueron considerados protectores del surgimiento de alteraciones en la piel, mientras que los principales motivos para el cambio de la mascarilla N95 fueron la humedad, la pérdida del sellado, la contaminación y daños (rotura).

Conclusión: Se concluye que los profesionales de la salud de sexo masculino presentaron más probabilidades de tener alteraciones en la piel relacionadas con el uso de mascarillas N95. Se destacaron los factores protectores y resulta importante la realización de estudios experimentales con la finalidad de explorar medidas para la prevención de este tipo de lesiones.

Introduction

Since 2019, when an outbreak of respiratory infection occurred in the city of Wuhan, China, caused by the Severe Acute Respiratory Syndrome related Coronavirus-2 (SARS-CoV-2) virus, which is the causative agent of the disease called coronavirus disease (COVID-19), health professionals have gone through different experiences to manage this new health condition, from primary care to hospital services.[1]

SARS-CoV-2 is transmitted through contact between people, through respiratory droplets, which are expelled during speech, coughing and sneezing. Transmission can also occur through indirect contact with objects and surfaces that are contaminated. The virus penetrates the body through the mucous membranes of the mouth, nose and eyes, and acts mainly on the airways.[1-3] Due to its high and rapid transmissibility, the number of contaminated people and deaths continues to increase globally. Until February 2022, around the world, 431,422,036 contaminated and 5,928,470 deaths were registered; in Brazil, about 28,580,995 contaminated and 647,486 deaths, and in the North region, the number of cases reached 2,108,000, while the number of deaths was 49,377.[4]

Given the speed of dissemination of SARS-CoV-2, health services had to undergo a reorganization, which consisted of the creation of new care protocols, review of flows, acquisition of supplies, personal protective equipment (PPE), training of health professionals to meet emerging demands. The unpreparedness of the health system, in the face of the new situation, ended up generating a global collapse. In most countries, a discussion has begun about how to effectively protect health professionals, especially those who work on the front lines of fighting the pandemic. Health professionals' exposure to biological risks can have negative consequences, either due to lack of equipment or knowledge based on scientific evidence or due to non-adoption or insufficient adoption of the recommended measures.[5-9]

Health professionals are characterized as a risk group for COVID-19 due to the fact that they are in direct contact with infected patients, thus receiving a high viral load; in addition, they are constantly subjected to stressful situations, as they often care for patients in serious situations, usually in inadequate working conditions. Moreover, it is known that the population that makes up this workforce is heterogeneous, as it presents differences in sex, race and social class, which structuring access to different levels and courses of professional training, which ends up determining different forms of exposure, being necessary to pay attention to each one's specificities.[10-12]

According to the World Health Organization (WHO), protecting the health of health professionals is essential to prevent the transmission of COVID-19 in health facilities and in their homes, as it is necessary to adopt infection control protocols and provide PPE, including N95 masks, aprons, glasses, face shields and gloves, the adoption of these equipment constitutes non-pharmacological interventions (NPI).[9,13]

Such measures, when adopted at the beginning of an epidemic period, enhance the prevention of transmission, decrease the speed of contamination, and consequently flatten the epidemic curve. Thus, it enables the reduction of the instant demand for health care and mitigation of the consequences of the disease on populations' health, including the reduction of associated morbidity and mortality.[13] Therefore, inadequate and prolonged mask use is responsible for constant friction and pressure forces on facial skin tissues, leading professionals to suffer skin changes.[14-17] In this context, the present study aims to identify the factors associated with N95 mask use related to skin changes among health professionals in northern Brazil during the COVID-19 pandemic.

Methods

This study was carried out in northern Brazil from October to December 2020. It is part of a multicenter project entitled "*Efeitos e consequências da pandemia da COVID-19 entre os profissionais de saúde no Brasil*". For the present study, health professionals from northern Brazil were selected.

We included 1,684 health professionals who responded to variables related to skin changes related to N95 mask use, over 18 years of age and who worked in health care during the COVID-19 pandemic.

The project had a team of researchers who underwent previous training for data collection. Data were gathered electronically and stored on the Survey Monkey platform. For the operationalization of data collection, social media containing the data collection questionnaire were used, namely: WhatsApp, Facebook, Instagram. The Informed Consent Form (ICF) it was contained on the first page of the questionnaire and the participant had access to the questions by accepting to participate in the research and signing the ICF online. It is noteworthy that using the Survey Monkey platform to store the collected responses allowed strict control of data security and the quality of responses through available settings. Possible sample selection biases were foreseen in the study planning, such as the absence of participants from certain states in the North. However, we sought to reduce bias through contact with researchers from all states to facilitate access to health professionals.

The data collection questionnaire consisted of multiple-choice questions, containing participant characterization, information on acting in the fight against the pandemic and related to N95 mask use and the consequences of prolonged use, such as skin changes. The instrument was built by the researchers themselves and submitted to validity by experts in the subject, later assessed by the application of a pilot test.

Independent variables included: sex; age group; professional category; skin color; job tenure; time since graduation; marital status; frequency of mask change N95; state of the North; education; area of expertise; provided assistance at a COVID-19 field hospital; received any training or course on COVID-19; the work institution provided sufficient PPE for use; the working institution provided good quality PPE; and main reason to change the N95 mask. Dependent variable included skin alteration related to N95 mask use (yes, no).

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 20.0, and descriptive statistics were used to characterize the sample, association tests (chi-square), considering the level of statistical significance at $p < 0.05$. Binary logistic regression analysis was performed to assess the extent to which independent variables exerted an influence on the dependent variable, skin change related to N95 mask use, considering a significance level of 5% ($\alpha = 0.05$) in the regression analysis.

The study was approved by the Research Ethics Committee of the *Escola de Enfermagem*

de Ribeirão Preto, under Opinion 4.258.366 and CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 33539820.3.0000.5393. All participants signed the ICF. Participant anonymity was guaranteed by the researchers.

Results

The study included 1,684 health professionals from northern Brazil, 835 (49.6%) nurses, 1,264 (75.1%) women, 921 (54.7%) aged between 31 and 50 years old, 1,056 (62.7%) of mixed race, 854 (50.7%) with up to 5 years of professional experience in the health area, 734 (43.6%) had graduated for up to 5 years. Regarding the frequency of changing the N95 mask, 407 (27.7%) reported changing their masks between five and six days. Time of use was the main reason for changing the N95 mask (597; 35.5%). Moreover, 1,112 (66%) received some training or course on COVID-19 (Table 1).

Table 1. Sample characterization

Variables	n(%)	p-value
Professional category		
Physician	161(9.6)	0.07
Nurse	835(49.6)	
Nursing technician	471(28.0)	
Nursing assistant	14(0.8)	
Physical therapist	70(4.2)	
Psychologist	27(1.6)	
Speech therapist	2(0.1)	
Occupational therapist	5(0.3)	
Dentist	34(2.0)	
Other	65(3.9)	
Sex		
Male	420(24.9)	0.000
Female	1264(75.1)	
Age group (years)		
18 to 30	672(39.9)	0.000
31 to 50	921(54.7)	
50 years and older	91(5.4)	
Skin color		
White	447(26.5)	0.144
Black	159(9.4)	
Brown	1056(62.7)	
Yellow	22(1.3)	
Job tenure (full years)		
0 to 5	854(50.7)	0.001
7 to 12	414(24.6)	
13 to 17	196(11.6)	
18 years and above	220(13.1)	
Time since graduation (full years)		
0 to 5	734(43.6)	0.000
7 to 12	458(27.2)	
13 to 17	248(14.7)	
18 years and above	244(14.5)	
Marital status		
Single/divorced	867(51.5)	0.035
Married/stable union	805(47.8)	
Widow	12(0.7)	
N95 mask change frequency*		
Less than 3 days	402(23.9)	0.000
Between three and four days	375(22.3)	
Between five and six days	407(27.7)	
Between six and seven days	18(1.1)	
Between seven and eight days	2(0.1)	
Between nine and ten days	95(5.6)	
More than ten days	7(0.4)	
State of northern Brazil		
Acre	150(8.9)	0.128
Amapá	65(3.9)	
Amazonas	202(12.0)	
Pará	707(42.0)	
Rondônia	133(7.9)	
Roraima	124(7.4)	
Tocantins	303(18.0)	
Education		
High school	334(19.8)	0.144
Higher education	491(29.2)	
Graduate education	859(51.0)	
Area of expertise*		
Infectiology	22(1.3)	0.000
General practitioner	161(9.6)	
Gynecology and obstetrics	88(5.2)	
Surgery	67(4.0)	
Intensive care	247(14.7)	
Psychiatry	14(0.8)	
Emergency	376(22.3)	
Other	514(30.05)	
Provided assistance at a COVID-19 field hospital		
Yes	610(36.2)	0.000
No	1074(63.8)	
Receive any training or course on COVID-19		
Yes	1112(66.0)	0.017
No	572(34.0)	
The work institution provided sufficient PPE for use		
Yes	1068(63.4)	0.000
No	145(8.6)	
In part	471(28.0)	
The work institution provided good quality PPE		
Yes	821(48.8)	0.000
No	261(15.5)	
In part	602(35.7)	
Main reason for changing the N95* mask		
Humidity	229(13.6)	0.001
Loss of seal	82(4.9)	
Time of use	597(35.5)	
Contamination	268(15.9)	
Damage (tear)	60(3.6)	
Established routine	371(22.0)	
Other	31(1.8)	

*Missing

The following variables were statistically significant: sex (p = 0.000), age group (p = 0.000), job tenure (p = 0.001), time since graduation (p = 0.000), marital status (p = 0.035), frequency of mask change N 95 (p = 0.000), area of expertise (p = 0.000), provided assistance at a COVID-19 field hospital (p = 0,000), received some training or course on COVID-19 (p = 0,017), the work institution provided sufficient PPE for use (p = 0,000), the institution provided good quality PPE (p = 0.000) and the main reason for changing the N95 mask (p = 0.001).

Regarding the factors associated with skin changes related to N95 mask use among Brazilian health professionals during the COVID-19 pandemic, we observed that male health professionals were 1.708 (AOR 1.708, 95% CI: 1.333 – 2.189; p= 0.000) times more likely to have skin changes related to N95 mask use when compared to female health professionals.

Furthermore, the following variables were protective factors for the development of skin changes related to N95 mask use: changing the N95 mask between three and four days of use (AOR 0.613, 95% CI: 0.431 – 0.873; p = 0.007); changing the N95 mask between five and six days of use (AOR 0.559, 95% CI: 395 – 791; p = 0.001); changing the N95 mask between nine and ten days of use (AOR 0.409, 95% CI: 0.236 – 0.709, p = 0.001); working in intensive care (AOR 0.645, 95% CI: 0.451 – 0.923, p = 0.016); working in emergency situations (AOR 0.619, 95% CI: 0.457 – 0.839, p = 0.002); having provided assistance at a COVID-19 field hospital (AOR 0.633, 95% CI: 0.501 – 0.801; p = 0.000); having received some training or course on COVID-19 (AOR 0.633, 95% CI: 0.501 – 0.801; p = 0.000).

The main reasons for switching to N95 masks were: humidity (AOR 0.429, 95% CI: 0.202 – 0.911, p = 0.028); the loss of sealing (AOR 0.331, 95% CI 0.139 – 0.789; p = 0.013); contamination (AOR 0.354, 95% CI: 0.168 – 0.748; p = 0.007); and damage (tear) (AOR 0.348, 95% CI: 0.139 - 0.871; p = 0.024) (Table 2).

Table 2. Adjusted model of factors associated with skin changes related to N95 mask use among Brazilian health professionals

Variables	Unadjusted Odds[95%CI]	p-value	Adjusted Odds [95%CI]	p-value
Professional category				
Physician	0.096 [- 0.758 – 0.670]	0.801	0.908 [0.463 – 1.781]	0.779
Nurse	0.169 [- 0.437 – 845]	0.576	1.184 [0.661 – 2.121	0.570
Nursing technician	0.167 [- 0.423 – 0.818]	0.613	1.182 [0.643 – 2.171]	0.591
Nursing assistant	0.337 [- 1.109 – 2.022]	0.634	1.401 [0.372 – 5.281]	0.619
Physical therapist	0.001 [- 0.832 – 0.876]	0.426	0.999 [0.451 – 2.215]	0.998
Psychologist	0.390 [- 0.580 - 1.606]	0.431	1.476 [0.551 – 3.959]	0.439
Speech therapist	20.9 [19.386 - 22.051]	0.001	1.317 [[0.591 – 2.134]	0.417
Occupational therapist	1.518 [-19.773 – 23.426]	0.125	4.561 [0.543 – 38.312]	0.162
Dentist	0.405 [- 0.575 – 1.5]	0.384	1.499 [0.587 – 3.827]	0.398
Other	Ref.		Ref.	
Sex				
Male	0.536 [0.300 – 0.818]	0.001	1.708 [1.333 – 2.189]	0.000
Female	Ref.		Ref.	
Age group (years)				
18 to 30	0.480 [- 1.108 – 0.137]	0.106	0.619 [0.344 – 1.113]	0.109
31 to 50	0.025 [-0.555 – 0.545]	0.902	0.975 [0.584 –1.628]	0.923
50 years and older	Ref.		Ref.	
Skin color				
White	0.212 [-0.863 – 1.659]	0.685	1.236 [0.474 –3.224]	0.665
Black	0.423 [-0.644 – 1.877]	0.458	1.527 [0.561 – 4.152]	0.407
Brown	0.452 [-0.568 – 1.883]	0.404	1.571 [0.610 – 4.046]	0.349
Yellow	Ref.		Ref.	
Job tenure				
0 to 5	0.168 [-0.889 – 0.498]	0.595	0.846 [0.436 – 1.640]	0.620
7 to 12	0.405 [-1.131 – 0.245]	0.219	0.667 [0.355 – 1.254]	0.209
13 to 17	0.431 [1.100 – 0.226]	0.188	0.650 [0.351 – 1.201]	0.169
18 years and above	Ref.		Ref.	

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Continuation.

Time since graduation				
0 to 5	0.233 [-0.984 – 0.482]	0.480	0.792 [0.408 – 1.539]	0.492
7 to 12	0.014 [-0.628 – 0.716]	0.972	1.014 [0.547 – 1.1881]	0.965
13 to 17	0.042 [-0.611 – 0.691]	0.890	1.043 [0.578 – 1.882]	0.888
18 years and above	Ref.		Ref.	
Marital status				
Single/divorced	0.505 [-2.100 – 0.751]	0.385	0.604 [0.178 – 2.051]	0.419
Married/stable union	0.413 [-2.045 – 0.900]	0.494	0.661 [0.196 – 2.235]	0.506
Widow	Ref.		Ref.	
N95 mask change frequency*				
Less than 3 days	0.257 [-.617 – 0.082]	0.145	0.774 [0.553 – 1.083]	0.134
Between three and four days	0.489 [-.882 – (-0.147)]	0.008	0.613 [0.431 – 0.873]	0.007
Between five and six days	0.581 [-.962 – (-0.250)]	0.001	0.559 [395 – 791]	0.001
Between six and seven days	0.874 [-2.465 – 0.260]	0.128	0.417 [0.136 – 1.279]	0.126
Between seven and eight days	0.447 [-20.009 – 20.610]	0.202	1.564 [0.045 – 54.640]	0.805
Between nine and ten days	0.894 [-1.567 – (-0.374)]	0.001	0.409 [0.236 – 0.709]	0.001
More than ten days	Ref.		Ref.	
State of northern Brazil				
Acre	0.324 [-0.744 – 0.152]	0.144	0.723 [0.465 – 1.125]	0.150
Amapá	0.104 [-0.839 – 0.557]	0.758	0.902 [0.490 – 1.659]	0.739
Amazonas	0.041[-0.488 – 0.390]	0.809	0.960 [0.641 – 1.438]	0.842
Pará	0.322 [-0.668 – 0.027]	0.058	0.725 [0.527 – 0.996]	0.047
Rondônia	0.039 [-0.489 – 0.405]	0.882	0.962 [0.608 – 1.521]	0.868
Roraima	0.460 [-1.024 0.059]	0.078	0.631 [0.386 – 1.031]	0.066
Tocantins	Ref.		Ref.	
Education				
High school	0.267 [-0.230 – 0.758]	0.260	1.306 [0.835 – 2.042]	0.242
Higher education	0.149 [-0.180 – 0.456]	0.304	1.160 [0.873 – 11.542]	0.305
Graduate education	Ref.		Ref.	
Area of expertise				
Infectiology	0.030 [-1.084 – 0.963]	0.939	0.970 [0.380 – 2.478]	0.949
General practitioner	0.289 [-0.749 – 0.138]	0.172	0.749 [0.496 – 1.129]	0.167
Gynecology and obstetrics	0.110 [-0.683 – 0.432]	0.678	0.896 [0.540 – 1487]	0.671
Surgery	0.153 [-0.418 – 0.774]	0.606	1.166 [0.668 – 2.034]	0.589
Intensive care	0.438 [-0.851 – (-0.116)]	0.013	0.645 [0.451 – 0.923]	0.016
Psychiatry	0.211 [-1.241 – 1.686]	0.731	1.235 [0.389 – 3.920]	0.720
Emergency	0.479 [-0.844 – (-0.168]	0.003	0.619 [0.457 – 0.839]	0.002
Other	Ref.		Ref.	
Provided assistance at a COVID-19 field hospital				
Yes	0.457 [-0.693 – (-0.205)]	0.001	0.633 [0.501 – 0.801]	0.000
No	Ref.		Ref.	
Receive any training or course on COVID-19				
Yes	0.291 [-0.544 – (-0.049)]	0.013	0.747 [0.591 – 0.945]	0.015
No	Ref.		Ref.	
The work institution provided sufficient PPE for use				
Yes	0.446 [0.129 – 0.774]	0.004	1.562 [1.157 – 2.108]	0.004
No	0.397 [0.094 – 0.918]	0.121	1.488 [0.931 – 2.378]	0.097
In part	Ref.		Ref.	
The work institution provided good quality PPE				
Yes	0.291 [-0.009 – 0.622]	0.055	1.338 [1.010 – 1.773]	0.043
No	0.218 [0.673 – 0.134]	0.292	0.804 [0.553 – 1.169]	0.254
In part	Ref.		Ref.	
Main reason for changing the N95* mask				
Humidity	0.847 [-1.746 – (-0.088)]	0.026	0.429 [0.202 – 0.911]	0.028
Loss of seal	1.105 [-2.277 – (-0.230)]	0.027	0.331 [0.139 – 0.789]	0.013
Time of use	0.697 [-1.540 – 0.018]	0.062	0.498 [0.241 – 1.030]	0.06
Contamination	1.037 [-1.982 – (-0.292)]	0.008	0.354 [0.168 – 0.748]	0.007
Damage (tear)	1.054 [-2.164 – (-0.180)]	0.024	0.348 [0.139 – 0.871]	0.024
Established routine	0.856 [-1.776 – (-0.117)]	0.030	0.783 [0.281 – 2.184]	0.641
Other	Ref.		Ref.	

Discussion

Data collection for this research took place in the initial period of the pandemic caused by SARS-CoV-2, between October and November 2020, and its result is a photograph in the initial moments so that this research may not represent the current reality, post-vaccination period and with protocols reorganized after two years of pandemic. This time factor, associated with a reduced number of studies addressing factors related to skin changes caused by N95 mask use, are the main limitations of this study.

However, knowing the history of the pandemic and its consequences among health professionals is necessary, given that future social, health and occupational measures depend on the measures instituted in the present.[18] In addition to this, research carried out during the pandemic is particularly important in the face of a rapidly evolving health crisis.

The findings of this study revealed that male health professionals were more likely to develop skin changes related to N95 mask use. This result is reinforced by another study, in which the perception of sex issues and behaviors that favor the health-disease process is that women are favored in terms of body care. In general, men comply less with self-care practice, and it is possible to suggest that several diseases could be avoided with prevention associated with self-care, but male resistance on this topic is still evident, given some conservative thoughts and lifestyle habits.[19]

The frequency of changing N95 masks was highlighted as an important skin protection factor, varying from three to six days. According to a survey carried out on the information of three main manufacturers (Nutriex®, 3M®, Wwdoll®), the use is variable, where it is recommended to use it for a work shift, and if there is occupational exposure to pathogens transmitted by contact, it is suggested to discard the product immediately after each use. None of the manufacturers brings in the recommendations an accuracy in relation to mask use time. They only inform that factors such as concentration of contaminants, users' respiratory rate, temperature and relative humidity of the environment influence the product saturation. It is worth noting that northern Brazil, a large part of its Equatorial climate, has high temperatures (averages above 27°C), which can reach more than 35°C, has as a reality, in health units in the region, environments without environmental conditioning, so heat and relative humidity are important factors in limiting mask use.

N95 mask reuse and cleaning with washing and application of 70% alcohol compromise their effectiveness and increase the risk of contamination by aerosols; therefore, the number of mask use by the same professional must consider the routines established by the health service's Hospital Infection Control Commission (HICC) and be included in the reuse protocol. In addition to this, where N95 mask availability is limited or in short supply, WHO has suggested considering both prolonged use and appropriate reprocessing of this PPE.[20-22] Although this factor was not assessed in the present research, its relevance is highlighted and it is suggested that in future research it be investigated, since, in extreme situations, such as the pandemic, due to the high demand and lack of hospital supplies, N95 mask reuse is necessary and frequent.

In the present research, professionals working in the intensive care, emergency services and COVID-19 field hospital had greater protection against skin changes. These professionals are used to environments in which the work routine is intense, with constant exposure to various risks to the team, requiring effective adherence to standard precautionary measures (PP). Therefore, the fact that these professionals are already used to the constant PPE use may be related to the fact that the mentioned expertises have been protective factors for the development of skin changes related to N95 mask use.[16,23]

Additionally, participants who received some training or course on COVID-19 were more protected in relation to the development of skin changes. Insufficient and inadequate knowledge about the correct use of PPE can compromise professionals' physical integrity. The most common

errors refer to the donning and doffing sequence, validity period of PPE, inadequate reuse of disposable materials and supplies used for disinfection, which emphasizes the need to prepare professionals so that there is a correct and conscious use, allowing a safe environment of health services.[16,22,24] The importance of continuous professional training is highlighted, which, in addition to expanding skills through learning, contributes to greater security for professionals in their routine in dealing with patients, especially in the stressful situation in the face of the pandemic.

Regarding the exchange of N95 masks, the main reasons listed were humidity, loss of sealing, contamination and damage (tear). It is recommended to discard the mask when it is damaged, punctured, with loose or broken elastics, when users' breathing becomes difficult, when it is contaminated by blood or other body fluids, or if there are deformations in its physical structure that can cause the loss of face seal (manufacturers). A study carried out in 2020 showed that about 42.8% of professionals had skin injuries due to prolonged PPE use, one of the most common injuries being skin damage associated with humidity.[25]

The N95 type respiratory protection masks, due to the exceptionality of the moment, could be used for a longer period than recommended by the manufacturer, as long as the necessary care was followed, namely: wet, dirty, torn, wrinkled or creased masks should be discarded immediately, whereas, in the impossibility of a careful verification of mask seal to professionals' face, the same should happen.[20]

It is noteworthy that in the literature there are few studies on the subject. According to a study conducted in China, the main injuries related to N95 mask use are: medical device-related pressure injury (MDRPI), humidity injury and friction injury. In addition, hydrocolloid plate use proved to be effective in preventing these types of injuries.[25] Thus, the use of said mask for a prolonged period of time causes damage to professionals' skin. A survey of 542 workers identified that 97% of them developed skin changes associated with N95 mask use, such as erythema, papules, maceration and scaling.[26]

Conclusion

We concluded that male health professionals were more likely to have skin changes related to N95 mask use. Thus, it becomes relevant to carry out intervention studies in order to explore measures to prevent these types of injuries. Additionally, issues related to the consequences and effects of the pandemic among health professionals have not been fully elucidated. Prolonged N95 mask use will remain for many professionals providing assistance in the context of COVID-19; thus, it is necessary to study the influence of these injuries on health professionals' physical and mental health as well as alternatives to avoid or minimize them. Furthermore, there is a need for investigations that better elucidate the influence of protective factors identified in this study on the dynamics of prevention in the development of skin injuries.

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Collaborations

Schimidt CP, Marson PG, Evangelista DR, Oliveira e Silva AC, Gir E and Sousa LRM contributed to study design, data analysis and interpretation, article writing, relevant critical review of the intellectual content and approval of the final version to be published.

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