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Complications of personal protective equipment use during the COVID-19 pandemic

Complicações da utilização de equipamentos de proteção individual na pandemia de COVID-19

Complicaciones de la utilización de equipos de protección individual en la pandemia de COVID-19

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Abstract
Background: COVID-19 was declared a pandemic in 2020. Personal protective equipment (PPE) emerged as an effective measure to prevent and control transmission, resulting in several complications for health professionals.
Objectives: To identify complications related to PPE use.
Methodology: A descriptive cross-sectional study was carried out with 118 professionals from a local health unit who received an email invitation from the department manager to answer an online questionnaire. It received a favorable opinion from an Ethics Committee.
Results: Most complications were associated with FPP2 respirators (96.6%), gowns (79.6%), and coveralls (89.3%), namely hyperhidrosis from wearing coveralls (95.3%), aprons (93.1%), and gowns (92.0%), falls from using shoe covers (94.6%), xeroderma from wearing gloves (65.2%), and oral communication difficulties due to mask use.
Conclusion: The most frequent complications were hyperhidrosis, falls, and xeroderma. Oral and skin hydration is recommended. PPE should be worn for the minimum time possible.

Keywords: COVID-19; personal protective equipment; adverse effects

Resumo
Enquadramento: Em 2020, a COVID-19 é declarada pandemia. Os equipamentos de proteção individual (EPIs) surgem como medida eficaz para prevenir e controlar a transmissão, provocando diversas complicações nos profissionais.
Objetivos: Identificar as complicações decorrentes da utilização de EPIs.
Metodologia: Estudo transversal descritivo realizado em 118 profissionais de uma unidade local de saúde, responderam a um questionário *online,* através do convite, via email, do gestor do serviço. Parecer favorável da Comissão de Ética.
Resultados: O respirador FPP2 (96,6%), a bata (79,6%) e o fato integral (89,3%) foram responsáveis pela maioria das complicações, predominou a hiperidrose relacionada com o uso de fato integral (95,3%), avental (93,1%) e bata (92,0%), as quedas associadas ao uso dos protetores dos sapatos (94,6%), a xerodermia com o uso de luvas (65,2%) e a dificuldade na comunicação verbal relacionada com o uso de máscaras.
Conclusão: As complicações mais frequentes foram a hiperidrose, as quedas e a xerodermia, sugerindo-se o reforço de hidratação oral e cutânea bem como a limitação de utilização dos EPIs ao tempo absolutamente necessário.

Palavras-chave: COVID-19; equipamento de proteção individual; efeitos adversos

Resumen
Marco contextual: En 2020, el COVID-19 se declara pandemia. Los equipos de protección individual (EPI) surgen como medida eficaz para prevenir y controlar la transmisión, lo que provoca diversas complicaciones en los profesionales.
Objetivos: Identificar las complicaciones derivadas del uso de EPI.
Metodología: Estudio transversal, descriptivo, realizado en 118 profesionales de una unidad de salud local, que respondieron un cuestionario en línea a través de una invitación, vía correo electrónico, del responsable del servicio. Dictamen favorable del Comité de Ética.
Resultados: El respirador FPP2 (96,6%), la bata (79,6%) y el traje general (89,3%) fueron los responsables de la mayoría de las complicaciones, la hiperhidrosis relacionada con el uso del traje general (95,3%), el delantal (93,1%) y la bata (92,0%), las caídas asociadas al uso de cubrezapatos (94,6%), la xerodermia con el uso de guantes (65,2%) y la dificultad en la comunicación verbal relacionada con el uso de mascarillas.
Conclusión: Las complicaciones más frecuentes fueron hiperhidrosis, caídas y xerodermia, lo que sugiere reforzar la hidratación oral y cutánea, así como limitar el uso de EPI al tiempo absolutamente necesario.

Palabras clave: COVID-19; equipo de protección personal; efectos adverso

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Introduction

At the end of 2019, a highly contagious virus spread fear worldwide, putting us all in a constant state of alert and apprehension. The COVID-19 pandemic has been in the spotlight since then, namely since 11 March 2020 when the World Health Organization (WHO) declared it a public health emergency of international concern (Gerolin et al., 2020).

There is currently no specific treatment for coronavirus infections. Symptoms are treated using medications such as antipyretics and analgesics. In more severe cases associated with severe respiratory failure and pneumonia, hospitalization is required, often in intensive care units, as well as endotracheal intubation and mechanical ventilation (World Health Organization, 2020). Due to the initial lack of knowledge of this novel coronavirus, its modes of transmission, and effective treatments, personal protective equipment (PPE) was the most effective way of preventing and controlling transmission (Hu et al., 2020). Wards and institutions had to reorganize and reinvent themselves to respond to this serious problem by creating dedicated COVID-19 care areas and teams with extended working hours due to the high affluence (Luz et al., 2020). Health professionals are on the frontline in the fight against this virus, risking their lives and experiencing very adverse situations of physical and psychological distress (Chen & Chi, 2020). They were at high risk of exposure to the virus due to the initially limited availability of PPE, their inadequate use, and the lack of specific training in the area (Darlenski & Tsankov, 2020). The prolonged use of PPE leads to reports of both physical and psychological complications (Luz et al., 2020). Several studies found a high prevalence of adverse effects, ranging from 42.8% to 95.1%. The high frequency of glove use and hand hygiene has contributed to an increase in dermatitis and dermatoses, causing, for example, itching, erythema, dehydration, fissures, infections, and allergies, as well as exacerbation of pre-existing skin diseases (Darlenski & Tsankov, 2020). Respirators, such as N95 or filtering face piece class 2 (FFP2), and goggles also increase the risk of facial pressure injuries due to friction. There are also reports of doctors and nurses feeling exhausted and losing weight due to dehydration after long shifts wearing PPE and difficulty eating, drinking, or taking bathroom breaks to avoid having to remove PPE (Duan et al., 2021). Thus, this study aims to identify complications related to PPE use.

Background

The Portuguese Directorate-General for Health (DGS, 2020, p. 6) considers PPE "any equipment that serves as a barrier to protect the mucous membranes, skin, and clothing from contact with infectious agents". The type of PPE recommended for health professionals depends on the COVID-19 care setting, ranging from masks, gloves, goggles or clear plastic face shields or equivalent, water-resistant clothing/apron, coveralls, caps, specific boots, or closed shoes (DGS, 2020; Duan et al., 2021). These recommendations helped health professionals to properly use PPE, ensuring their protection and safety and the sustainability of access to PPE. DGS (2020) recommends that all professionals use a surgical mask throughout their stay in hospital or primary health care settings, replacing it every 4 to 6 hours or whenever it is wet. It also recommends professionals providing direct care to suspected or confirmed cases of COVID-19 to use PPE for contact and droplet isolation, including: (a) gown, with back opening, disposable, waterproof/fluid-resistant, long-sleeved, and knee length; (b) mask; (c) eye protection (goggles or face shield); (d) disposable, non-sterile gloves; (e) shoe covers if professionals are not using dedicated washable footwear; (f) cap; (g) and additional respiratory isolation measures (DGS, 2020). Almeida (2020) considers that PPE plays a unique role in protecting professionals' health in the current pandemic, given that they act as barriers that can prevent infection in case of risk of biological contamination. According to the World Health Organization (WHO, 2020), all healthcare workers and providers should be trained in infection prevention and control practices, including risk assessment, standardized and transmission-based precautions, and donning and doffing of PPE to ensure that PPE are used effectively and are not a source of contamination for those using them. Duan and Zhu (2020) point out that health professionals often experience difficulties providing care to patients due to uncomfortable multi-layered PPE that affect their performance. In addition, each manufacturer and brand require these professionals to follow different procedures. Wearing only one PPE can lead to poor performance, while wearing multiple PPE simultaneously can significantly affect health professionals' ability to provide patient care (Duan & Zhu, 2020). Thus, the effects caused by the need for prolonged PPE use in COVID-19 patient care should be analyzed, considering the initial scarcity of PPE and the heavy workloads to which health professionals were exposed (Galanis et al., 2021). Prolonged use of masks and respirators, namely N95/FFP2 and goggles, seem to increase the risk of facial pressure injury due to friction (Darlenski & Tsankov, 2020). According to WHO (2020), prolonged face mask use can lead to facial skin lesions, irritant dermatitis, or worsening acne. Elston (2020) also found that healthcare workers develop medical device-related pressure injuries, namely due to prolonged use of N95 masks, reporting a 97% prevalence of skin changes.

Pressure injury due to the use of goggles was also found. As pointed out by Luz et al. (2020), the sites most affected by these injuries are the nasal, malar, zygomatic, temporal, and frontal regions. Lan et al. (2020) also found that 97% of healthcare workers had skin damage due to PPE use (N = 542). The main sites of injury were the nasal bridge (83%) due to goggle use; cheeks (74.5%) due to N95 mask use, and forehead (57.2%) due to face shield use. Hand damage (74.5%) occurred in professionals who washed their hands more than 10 times a day and wore gloves for a long time. Hu et al. (2020) concluded that skin lesions are very common among nurses and posi-

tively correlated with self-efficacy, resilience, and social support. They also found that a large number of nurses did not treat their skin lesions due to lack of knowledge or available medications. Thus, appropriate training on skin lesion prevention and adequate medications to treat skin lesions should be guaranteed. Jiang et al. (2020) concluded that about 43% of healthcare workers had skin injuries due to prolonged PPE use, namely device-related pressure injuries, moist-associated skin damage, and skin tear. Moura et al. (2020) highlighted the importance of protecting healthcare workers, given that skin injuries or changes are gateways to other viral, fungal, or bacterial hospital-acquired infections, altering the skin's normal bacterial flora and, consequently, its natural protective function (Galanis et al., 2021). Ong et al. (2020) surveyed 158 healthcare professionals aged 21-35 years, revealing that 29.1% had a pre-existing headache diagnosis and 81% developed de novo PPE-associated headaches, with intensivists being the most affected group. In the COVID-19 outbreak, 91.3% of respondents with a pre-existing headache diagnosis agreed that PPE use aggravated their headaches. Adverse events such as difficulty breathing were also reported. The respiratory discomfort from mask use confirms dyspnea as a common adverse event associated with PPE use. However, other factors may also have contributed to increased respiratory distress, such as higher anxiety and stress levels during the pandemic (Galanis et al., 2021). Ruskin et al. (2021) give the example of N95 masks, to the extent that the pressure inside the mask is lower than ambient pressure during inspiration, which increases work of breathing.

There are reports of doctors and nurses feeling exhausted and losing weight due to dehydration after long shifts with PPE (Duan et al., 2021). Intensive care teams have reported difficulty eating, drinking, or even taking bathroom breaks to avoid removing PPE (Alves et al., 2020; Duan et al., 2021). As suggested by Duan et al. (2021), PPE in COVID-19, use also has many negative impacts on health professionals' performance, including reduction of dexterity due to the thickness of protective clothes and/or gloves (28%), visual impairment due to wearing protective goggles (27%), communication obstacles (19%), increase in time-consuming practice while wearing non-uniform protective clothing (12%); increased risk of contamination while removing PPE (12%); and risk of injury due to sharp tools (2%). This study also analyzed the discomfort and injuries caused by PPE, with 97% of participants reporting discomfort, including labored breathing (20%), fatigue (16%), device-related pressure injuries (13%), anxiety (12%), face acne (10%), insomnia (8%), depression (6%), allergic dermatitis (4%), hand maceration or foot erosion (4%), trunk or limbs heat rash (3%), conjunctivitis or keratitis (2%), and perineal maceration or tinea corporis (2%). In addition to individual difficulties, there are challenges in team collaboration, as they may need more time to organize and recognize themselves as everyone is dressed in the same uniform (Duan et al., 2021). In addition, respirators, such as KN95 masks, can muffle speech, making communication difficult or nearly impossible, particularly in critical situations such as communicating medication dosage (Ruskin et al., 2021; Duan et al., 2021).

Research question

What are the complications of PPE use in workers of a local health unit in the North of Portugal during the COVID-19 pandemic?

Methodology

A descriptive cross-sectional study was conducted with professionals from the Intensive Care Unit, the Emergency Department, and the Internal Medicine Unit B Poente of a local health unit in northern Portugal who provided care to patients with COVID-19. Inclusion criteria were: 1) professionals who provided care to patients with COVID-19; 2) professionals who used PPE. Incomplete questionnaires were excluded. Thus, the sample consisted of 118 participants. A questionnaire was developed to collect information. It is divided into two parts: 1) sociodemographic characterization of the population (gender, age, education level, marital status, professional group, length of service, and service where they work); and 2) items related to the difficulties and complications of PPE use. In this study, the difficulties related to the obstacles that professionals faced in using PPE, while the complications related to the consequences, damage, and changes resulting from PPE use. The questionnaire was created in Google Docs, and the department manager sent an email invitation to the team members. After accessing it, they found an introductory note and the informed consent form. After consenting to participate in the study, they had access to the anonymous questionnaire. Data were collected between January 12 and February 8, 2022. This study was approved by the Ethics Committee (No. 25/2021). Data were entered into the IBM SPSS® Statistics database and analyzed using descriptive statistics. Absolute and relative frequencies were calculated for all variables, and the mean and standard deviation were calculated for continuous quantitative variables.

Results

Of the 118 participants, 28 were physicians, 60 nurses, and 30 operational assistants distributed by the three departments.

The majority of them were women (72%), with a mean age of 40 years (*SD* = 38.5 years), 44.1% had an undergraduate degree, 61.9% were married/cohabiting, 50.8% were nurses, the mean length of service was 12.6 years (*SD* = 12 years), and 52.5% worked in the Emergency Department.

Table 1

Distribution of the sociodemographic and professional variables (n = 118)

Variables		*n*	%	*M*	*SD*
Gender	Female	85	72.0		
	Male	33	28.0		
Age (years)				40	38.5
Education level	≤ 12th grade	25	21.2		
	3- or 4-year undergraduate degree	52	44.1		
	Master's degree	38	32.2		
	Doctoral degree	3	2.5		
Marital status	Single	37	31.4		
	Married/Cohabiting	73	61.9		
	Divorced/Separated	6	5.1		
	Widowed	2	1.7		
Professional group	Nurse	60	50.8		
	Physician	28	23.7		
	Operational assistant	30	25.4		
Length of service (years)				12.6	12.0
Department	Emergency	62	52.5		
	Intensive Medicine	36	30.5		
	Internal Medicine B Poente	20	16.9		

Note. *n* = Absolute frequency; % = Relative frequency, *M* = Mean; *SD* = Standard Deviation.

Gowns (42.4%), gloves (51.7%), surgical masks (51.7%), KN95 respirators (40.7%), FFP2 (60.2%), and caps (39.8%) were used for a longer time (Table 2).

Table 2

Distribution of PPE according to duration of use

PPE	PPE duration of use (%)			
	< 2 h	≥ 2 h and < 3 h	≥ 3 h and < 4 h	≥ 4 h
Apron	51.7	15.3	11.8	21.2
Gown	25.4	10.2	22.0	42.4
Coverall	52.5	7.6	9.4	30.5
Shoe/boot covers	52.5	7.6	16.2	23.7
Gloves	25.4	10.2	12.7	51.7
Arm sleeves	74.6	8.5	6.7	10.2
Surgical mask	33.1	6.8	8.4	51.7
KN95 Respirator	35.6	10.2	13.5	40.7
FFP2 Respirator	11.0	8.5	20.3	60.2
FFP3 Mask	73.7	9.4	5.9	11.0
Goggles	44.1	16.1	13.5	26.3
Cap	34.7	11.0	14.5	39.8
Face shield	58.5	10.2	13.5	17.8

Note. h = Hours; *Note*. PPE = Personal protective equipment.

A higher number of complications were associated with FFP2 respirators (96.6%) and coveralls (89.3%). The main difficulties were related to donning coveralls (71.2%), goggles and face shields (62.7%), and FFP2 respirators (52.5%) (Table 3).

Table 3

Distribution of the main complications associated with PPE use

PPE	Complications (%)		Difficulties (%)	
	With complications	Without complications	Difficult	Not difficult
Apron	24.6	75.4	24.6	75.4
Gown	79.6	20.4	39.8	60.2
Coverall	89.3	10.7	71.2	28.8
Shoe covers	47.5	52.5	49.2	50.8
Gloves	75.4	24.6	36.4	63.6
Arm sleeves	22.8	77.2	41.5	58.5
Surgical mask	80.5	19.5	28.8	71.2
KN95 Respirator	6.7	93.3	45.8	54.2
FFP2 Respirator	96.6	3.4	52.5	47.5
FFP3 Mask	7.6	92.4	31.4	68.6
Goggles	83.9	16.1	62.7	37.3
Cap	42.3	57.7	38.1	61.9
Face shield	80.5	19.5	62.7	37.3

Note. PPE = Personal protective equipment.

The most frequent complications were hyperhidrosis related to the use of aprons (93.1%), gowns (92.9%), and coveralls (95.3%); falls from wearing shoe covers (94.6%); xeroderma (65.2%) and skin irritation (64.0%) from wearing gloves; and itching (48.1%) due to arm sleeves and caps. The most common complications related to the use of goggles, face shields, masks, and respirators were visual difficulties, communication problems, and forehead and nasal injuries (Table 4).

Table 4

Distribution of the complications related to PPE use

PPE	Complications	Yes (%)	No (%)
Apron (*n* = 29)	Itching	10.3	89.2
	Irritability	13.8	86.2
	Hyperhidrosis	93.1	6.9
Gown (*n* = 94)	Itching	11.9	88.1
	Dehydration symptoms	20.2	79.8
	Hyperhidrosis	92.9	7.1
Coverall (*n* = 106)	Hearing difficulties	22.6	77.4
	Dehydration symptoms	30.2	69.8
	Hyperhidrosis	95.3	4.7
Shoe covers (*n* = 56)	Falls	94.6	5.4
Gloves (*n* = 89)	Skin irritation	64.0	36.0
	Xeroderma	65.2	34.8
	Flushing	40.4	59.6
Arm sleeves (*n* = 27)	Itching	48.1	51.9
	Irritability	25.9	74.1
	Skin irritation	37.0	63.0
Goggles (*n* = 99)	Vision difficulties	87.9	12.1
	Headaches	21.2	78.8
	Red eyes	16.2	83.8
Cap (*n* = 50)	Itching	60.0	40.0
	Hearing difficulties	26.0	74.0
	Headaches	22.0	78.0
Face shield (*n* = 95)	Oral communication difficulties	23.2	76.8
	Vision difficulties	77.9	22.1
	Headaches	28.4	71.6
Surgical mask *(n = 97)*	Oral communication difficulties	38.6	61.4
	Hyperhidrosis	38.1	61.9
	Pressure injuries on the forehead	35.9	64.1
KN95 Respirator (*n* = 97)	Oral communication difficulties	45.4	54.6
	Itchy nose	44.5	55.5
	Pressure injuries on the ears	38.1	61.9
FFP2 Respirator (*n* = 113)	Oral communication difficulties	49.6	50.4
	Pressure injuries on the nose	38.9	61.1
	Headaches	38.1	61.9
FFP3 Mask (*n* = 60)	Visual difficulties	40.0	60.0
	Headaches	33.3	66.7
	Oral communication difficulties	36.7	63.3

Note. PPE = Personal protective equipment.

Discussion

In this ample, there was a predominance of women, with a 3- or 4-year undergraduate degree, nurses, working in the Emergency Department, with a mean age of 40 years and a length of service of 12.6 years. Several studies corroborate the predominance of women in health professions with an undergraduate degree as a requirement for initial training (Duan et al., 2021; Moura et al., 2020). It is also known that nurses represent half of the workers in healthcare institutions (Galanis et al., 2021). As for age, these findings are not aligned with those in other studies, which point to younger professionals in emergency and intensive care settings due to the high level of stress and the

technical and scientific requirements (Alves et al., 2020; Duan et al., 2021; Jiang et al., 2020). FFP2 respirators, coveralls, goggles, surgical masks, and face shields were associated with more complications. Participants had more difficulties wearing coveralls, goggles, face shields, and masks. PPE are crucial to protect healthcare workers' health and should be properly donned and doffed to prevent the spread of particles, requiring training. Other studies also found that FFP2 respirators, coveralls, and goggles were associated with more difficulties in use (Almeida, 2020). WHO (2020) states that all healthcare workers and providers should receive training in donning and doffing PPE to ensure that they are used effectively and are not a source of contamination for those wearing them. Duan and Zhu (2020) report that healthcare workers often experience difficulties in providing care to patients due to uncomfortable, multi-layered PPE that affect their performance. The results also showed that gowns, disposable gloves, surgical masks, KN95 respirators, FFP2 respirators, and caps are the most common PPE and those worn for a longer time, following DGS recommendations (2020) for all health professionals to put on a surgical mask when entering the health institution and removing it only when leaving the facilities, replacing it every 4-6 hours or whenever it is wet. The most common complications were hyperhidrosis due to aprons, gowns, and coveralls; falls due to shoe covers; xeroderma and skin irritation due to glove use; and skin itching due to arm sleeves and caps. The most common complications from using goggles, face shields, and masks were visual difficulties, oral communication difficulties, and forehead and nasal pressure injuries. These data are aligned with studies that report the negative impacts of PPE on professionals' performance, especially when using multiple PPE, causing movement limitation, hyperhidrosis, and falls, among others (Duan & Zhu, 2020; Duan et al., 2021). Several studies show that xeroderma and itching are complications associated with the need for excessive hand hygiene and the use of disposable gloves and arm sleeves, increasing the risk of dermatitis and dermatoses, aggravation of skin diseases, and other changes (Casey et al., 2018; Choi et al., 2020; Darlenski & Tsankov, 2020; Galanis et al., 2021; Hu et al., 2020; Lan et al., 2020; Luz et al., 2020; Moura et al., 2020). Several studies point out that visual impairment, oral communication difficulties, and forehead and nasal pressure injuries are associated with the use of masks, goggles, and face shields, which are aggravated by the prolonged use of PPE (Alves et al., 2020; Casey et al., 2018; Choi et al., 2020; Darlenski & Tsankov, 2020; Duan et al., 2021; Duan & Zhu, 2020; Elston, 2020; Galanis et al., 2021; Hu et al., 2020; Jiang et al., 2020; Lan et al.,2020; Luz et al., 2020; Moura et al., 2020; Ong et al., 2020; Ruskin et al., 2021; WHO, 2020). Respirators, namely KN95 and FFP2, and goggles seem to increase the risk of facial pressure injury due to friction (Darlenski & Tsankov, 2020). Elston (2020) also found that healthcare workers develop medical device-related pressure injuries, namely due to the use of KN95 respirators, reporting a 97% prevalence of skin changes in healthcare workers. Pressure injury was also associated with goggles. According to Luz et al. (2020), the most affected sites are the nasal, malar, zygomatic, temporal, and frontal regions. There are also reports of doctors and nurses feeling exhausted and losing weight due to dehydration after long shifts wearing PPE (Duan et al., 2021). Since this was the first study conducted in Portugal on this topic, it is difficult to compare the results. The limitations include the small sample size and the online data collection. Given that it is the first study conducted in this context, the results highlight the difficulties and complications that healthcare workers are exposed to when using PPE for a long time, as occurred during the COVID-19 pandemic. PPE materials should reduce the complications found in this study.

Conclusion

Coveralls, FFP2 respirators, goggles, and face shields were associated with more complications. The most frequent complications were hyperhidrosis, falls, xeroderma, and oral communication difficulties. Gowns, disposable gloves, surgical masks, KN95 respirators, FFP2 respirators, and caps were used for more extended periods. Participants had more difficulties wearing coveralls, face shields, goggles, and FFP2 and KN95 respirators.

Preventive measures should be used to minimize complications, such as increasing hydration, reducing duration of use, whenever possible, and training professionals in donning and doffing PPE, namely coveralls. Further studies should be carried out with larger samples, prospective designs, and other variables that allow generalizations.

Author contributions

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References

Almeida, I. M. (2020). Proteção da saúde dos trabalhadores da saúde em tempos de COVID-19 e respostas à pandemia. *Revista Brasileira de Saúde Ocupacional, 45*, e17. https://doi.org/10.1590/scielopreprints.140

Alves, J., Reis, M., Barão, E., Souza. T., Guimarães, R., Almeida, L., Pereira, R., Freire, N., Germano, S., & Garrido, M. (2020). COVID-19: Impacto emocional da equipe de enfermagem na linha de frente no combate a pandemia. In R. Molin (Org.), *Saúde em foco:*

Temas contemporâneos (vol. 1., pp. 623-632). Editora Científica.

Casey, M., Mulkerns, A., O'Donnell, C., & McDonnell, T. (2018). Pulmonary rehabilitation in COPD: Current practice and future directions. In C. McCarthy (Ed.), *COPD: An update in pathogenesis and clinical management* (pp. 103-129). InTech.

Chen, C., & Chi, C. (2020). Biosafety in the preparation and processing of cytology specimens with potential coronavirus (COVID-19) infection: Perspectives from Taiwan. *Cancer Cytopathology, 128*(5), 309-316. https://doi.org/10.1002/cncy.22280

Choi, J., Kim, S., Lee, J., Park, Y., Kim, Y., Um, S., Jung, K., Yoo, K., Park, S., & Yoon, H. (2020). Clinical characteristics of chronic obstructive pulmonary disease in female patients: Findings from a KOCOSS cohort. *International Journal of Chronic Obstructive Pulmonary Disease, 15*, 2217-2224. https://doi.org/10.2147/COPD.S269579

Darlenski, R., & Tsankov, N. (2020). Covid-19 pandemic and the skin: What should dermatologists know?. *Clinics in Dermatology, 38*(6), 785-787. https://doi.org/10.1016/j.clindermatol.2020.03.012

Direção-Geral da Saúde. (2020). *Prevenção e controlo de infeção por SARS-CoV-2 (COVID-19): Equipamentos de proteção individual (EPI).* https://www.dgs.pt/directrizes-da-dgs/normas-e-circulares-normativas/norma-n-0072020-de-29032020-pdf.aspx

Duan, L., & Zhu, G. (2020). Psychological interventions for people affected by the COVID-19 epidemic. *Lancet Psychiatry, 7*(4), 300-302. https://doi.org/10.1016/S2215-0366(20)30073-0

Duan, Y., Peiris, D. L., Yang, M., Liang, W., Baker, J. S., Hu, C., & Shang, B. (2021). Lifestyle behaviors and quality of life among older adults after the first wave of the COVID-19 pandemic in Hubei China. *Public Health, 9,* 744514. https://doi.org/10.3389/fpubh.2021.744514

Elston, D. (2020). Occupational skin disease among health care workers during the coronavirus (COVID-19) epidemic. *Journal of American Academy of Dermatology, 82*(5), 1085-1086. https://doi.org/10.1016/j.jaad.2020.03.012

Galanis, P., Vraka, I., Fragkou, D., Bilali, A., & Kaitelidou, D. (2021). Impact of personal equipment use on health care workers' physical health during the COVID-19 pandemic: A systematic review and meta-analysis. *American Journal of Infection Control, 49*(10), 1305-1315. https://doi.org/10.1016/j.ajic.2021.04.084

Gerolin, F. S., Pires, A. M., Nascimento, C., Schimitt, C., Bucione, F. T., Rocha, J. S., Berlofi, L. M., & Ferrari, L. C. (2020). Ações de lideranças da enfermagem na organização do atendimento hospitalar a pacientes com COVID-19. *Enfermagem em Foco, 11*(2), 207-211. https://doi.org/10.21675/2357-707X.2020.v11.n2.ESP.3665

Hu, D., Kong, Y., Li, W., Han, Q., Zhang, X., Zhu, L. X., Wan, S. W., Liu, Z., Shen, Q., Yang, J., He, H., & Zhu, J. (2020). Frontline nurses' burnout, anxiety, depression, and fear statuses and their associated factors during the COVID-19 outbreak in Wuhan, China: A large-scale cross-sectional study. *EClinicalMedicine, 24*, 100424. https://doi.org/10.1016/j.eclinm.2020.100424

Jiang, Q., Song, S., Zhou, J., Liu, Y., Chen, A., Bai, Y., Wang, J., Jiang, Z., Zhang, Y., Liu, H., Hua, J., Guo, J., Han, Q., Tang, Y., & Xue, J. (2020). The prevalence, characteristics, and prevention status of skin injury caused by personal protective equipment among medical staff in fighting COVID-19: A multicenter, cross-sectional study. *Advances in Wound Care, 9*(7), 357-364. https://doi.org/10.1089/wound.2020.1212

Lan, J., Song, Z., Miao, X., Li, H., Li, Y., Dong, L., Yang, J., An, X., Zhang, Y., Yang, L., Zhou, N., Yang, L., Li, J., Cao, J., Wang, J., & Tao, J. (2020). Skin damage among health care workers managing coronavirus disease-2019. *Journal of the American Academy of Dermatology, 82(*5), 1215-1216. https://doi.org/10.1016/j.jaad.2020.03.014

Luz, A. R., Noronha, R. M., & Navarro, T. P. (2020). Covid-19: Medidas de prevenção de lesão por pressão ocasionadas por equipamentos de proteção individual em profissionais da saúde. *Revista Enfermagem Atual, 93,* e-02001. https://doi.org/10.31011/reaid-2020-v.93-n.0-art.768

Moura, A., Vaz, A., Ferreira, A., Alves, P., Ramos, P., Malcato, E., Sousa, F., Homem-Silva, P., Alves, P., & Dias, V. (2020). *Recomendação PREPI | COVID19:* Prevenção de lesões cutâneas causadas pelos equipamentos de proteção individual: (Máscaras faciais, respiradores, viseiras e óculos de proteção). *Journal of Tissue Healing and Regeneration*. https://www.spci.pt/media/enfermagem/cuidar-de-quem-cuida/aptferidas-recomendacao-prepi-covid19.pdf

Ong, J. J., Bharatendu, C., Goh, Y., Tang, J. Z., Sooi, K. W., Tan, Y. L., Tan, B. Y., Teoh, H., Ong, S., Allen, D. M., & Sharma, V. K. (2020). Headaches associated with personal protective equipment–a cross-sectional study among frontline healthcare workers during COVID-19. Headache: *The Journal of Head and Face Pain, 60*(5), 864-877. https://doi.org/10.1111/head.13811

Ruskin, K. J., Ruskin, A. C., Musselman, B. T., Harvey, J. R., Nesthus, T. E., & O'Connor, M. (2021). COVID-19, personal protective equipment, and human performance. *Anesthesiology, 134*, 518-525. https://doi.org/10.1097/ALN.0000000000003684

World Health Organization. (2020). *Rational use of personal protective equipment for COVID-19 and considerations during severe shortages.* https://www.who.int/publications/i/item/rational-use-of-personal-protective-equipment-for-coronavirus-disease-(covid-19)-and-considerations-during-severe-shortages