






## PERSONAL PROTECTIVE EQUIPMENT USED BY HEALTH PROFESSIONALS IN THE COVID-19 PANDEMIC: SCOPE REVIEW

EQUIPAMENTOS DE PROTEÇÃO INDIVIDUAL UTILIZADOS POR PROFISSIONAIS DA SAÚDE NA PANDEMIA DA COVID-19: REVISÃO DE ESCOPO

EQUIPO DE PROTECCIÓN PERSONAL UTILIZADO POR PROFESIONALES DE LA SALUD EN LA PANDEMIA COVID-19: REVISIÓN DEL ALCANCE

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### ABSTRACT

**Objective:** to map the use of personal protective equipment (PPE) by health professionals in coping with COVID-19. **Method:** scope review by the protocol proposed by the Joanna Briggs Institute. The search was performed in June 2020 using PubMed, CINAHL, LILACS databases. Inclusion criteria: full articles that followed the research objective, in English, Spanish and Portuguese, review articles, meta-synthesis, meta-analysis, quantitative, qualitative, and mixed. Exclusion criteria: editorials, correspondence, and articles without reporting to COVID-19. The extracted information was compared to each other, describing available evidence that answered the guiding question. **Results:** four articles were identified in LILACS, 101 in Pubmed, 35 in CINAHL, being 19 included in the synthesis, in English. Access to equipment was scarce, incomplete or of poor quality. Improper use and reuse increases the risk of contamination, which can be reduced with training. Long-term use caused adverse reactions. **Discussion:** as reduction, reuse and replacement practices, national and international protocols were created with guidelines for the reuse of respiratory mask N95 or equivalent, for a period longer than that foreseen by the manufacturer. The proper selection of PPE must be compatible with the patient's clinical situation. The main limitations of the research were the few publications of studies and the constant changes in the pandemic scenario. **Conclusion:** the mapping of the use of PPE revealed that the focus should be on the quality, form of use and prior control of the diagnosis for planning the rational use of equipment.

**Keywords:** Personal Protective Equipment; Health Personnel; COVID-19; Coronavirus Infections; Pandemics.

### RESUMO

**Objetivo:** mapear a utilização de equipamento de proteção individual (EPI) pelos profissionais da saúde no enfrentamento da COVID-19. **Método:** revisão de escopo pelo protocolo proposto pelo Instituto Joanna Briggs. A busca foi realizada em junho de 2020 utilizando as bases de dados PubMed, Cinahl, Lilacs. Critérios de inclusão: artigos na íntegra que seguem o objetivo da pesquisa, em inglês, espanhol e português, artigos de revisão, metassíntese, metanálise, quantitativos, qualitativos e mistos. Critérios de exclusão: editoriais, correspondências e artigos sem reportagem à COVID-19. As informações extraídas foram comparadas entre si, descrevendo evidências disponíveis que respondiam à questão norteadora. **Resultados:** foram identificados quatro artigos na Lilacs, 101 na Pubmed, 35 na Cinahl, sendo 19 incluídos na síntese, no idioma inglês. O acesso aos equipamentos foi escasso, incompleto ou de má qualidade. O uso inadequado e a reutilização aumentam o risco de contaminação, podendo diminuir com treinamento. O uso prolongado causou reações adversas. **Discussão:** como práticas de redução, reutilização e substituição foram criados protocolos nacionais e internacionais com orientações de reuso da máscara respiratória N95 ou equivalente, por período acima do previsto pelo fabricante. A seleção adequada do EPI deve ser compatível com a situação clínica do paciente. As principais limitações da pesquisa foram as poucas publicações de estudos e as constantes mudanças no cenário da pandemia. **Conclusão:** o mapeamento da utilização de EPI revelou que o foco deve estar na qualidade, na forma de utilização e no controle prévio do diagnóstico para planejamento do uso racional dos equipamentos.

**Palavras-chave:** Equipamento de Proteção Individual; Profissional da Saúde; COVID-19; Infecções por Coronavírus; Pandemias.

### RESUMEN

**Objetivo:** mapear el uso de equipos de protección personal (EPP) por parte de los profesionales de la salud para hacer frente al COVID-19. **Método:** revisión del alcance mediante el protocolo propuesto por el Instituto Joanna Briggs. La búsqueda se realizó en junio de 2020 utilizando las bases de datos PubMed, Cinahl, Lilacs. Criterios de inclusión: artículos completos que siguieron el objetivo de la investigación, en inglés, español y portugués, artículos de revisión, meta-síntesis, metaanálisis, cuantitativo, cualitativo y mezclado. Criterios de exclusión: editoriales, correspondencia artículos sin reportar a COVID-19. La información extraída se comparó entre sí, describiendo la evidencia disponible que respondió a la pregunta guía. **Resultados:** se identificaron cuatro artículos en Lilacs, 101 en Pubmed, 35 en Cinahl, siendo 19 incluidos en la síntesis, en inglés. El acceso al equipo era escaso, incompleto o de mala calidad. El uso y la reutilización inadecuados aumentan el riesgo de contaminación, que puede reducirse con formación. El uso prolongado provocó reacciones adversas.

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*Discusión:* como prácticas de reducción, reutilización y sustitución, se crearon protocolos nacionales e internacionales con orientaciones para la reutilización de la máscara respiratoria N95 o equivalente, por un período mayor al esperado por el fabricante. La selección adecuada de EPI debe ser compatible con la situación clínica del paciente. Las principales limitaciones de la investigación fueron las pocas publicaciones de estudios y los constantes cambios en el escenario pandémico. *Conclusión:* el mapeo del uso de EPI reveló que el foco debe estar en la calidad, forma de uso y control previo del diagnóstico para planificar el uso racional de los equipos. *Palabras clave:* Equipos de Protección Personal; Personal de Salud; COVID-19; Infecciones por Coronavirus; Pandemias.

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## INTRODUCTION

Respiratory-borne diseases represent a major concern for health authorities around the world. Recently, several countries were affected by the new virus SARS-CoV-2, the causative agent of coronavirus disease 2019 (COVID-19), highlighting severe acute respiratory syndrome (SARS). According to the Pan American Health Organization (PAHO), as of November 10, 2020, 50,676,073 cases and 1,261,075 deaths were confirmed worldwide.<sup>1</sup>

Health professionals on the front lines of combating the new coronavirus are considered one of the most vulnerable populations and susceptible to illness and transmission of infection by the coronavirus, due to their direct and constant contact with infected patients. Therefore, records of the World Health Organization (WHO) and other national and international public health agencies recommend the implementation of safety protocols and various strategies for the control of respiratory infections, which should be used for protection, especially, among them, the use of personal protective equipment (PPE), which are the most important materials for the maintenance of worker safety.<sup>2,3</sup>

The PPE is a set of protective equipment, which involves the use of a cap, goggles, or face shield (face shield), mask (surgical or respiratory protection, according to the procedure), waterproof long-sleeved apron (overalls), gloves, among others. This equipment works as a physical barrier that prevents health professionals from having direct contact with the various infectious agents and minimizes the risk of contamination.<sup>2-5</sup>

From this perspective, it is important to carry out a risk analysis to choose the most suitable PPE for each situation, considering the context, exposure time, availability, and product, in addition to the skills and competences of professionals during attire and undressing. Scarcity, lack of training, inadequate and unsafe use have been causes of contamination among health professionals, highlighting the need to prioritize their protection and safety.<sup>2-5</sup> With the advance of the pandemic, the shortage

of protective equipment was observed in several countries around the world, challenging health institutions and professionals who, on the one hand, recognize the importance of use and, on the other, maintain constant concerns about missing.<sup>2-5</sup>

Given the above scenario, the speed with which the new coronavirus continues to spread and the importance of using PPE to protect professionals in the fight against the pandemic, this scope review aimed to map the use of personal protective equipment by professionals of to fight COVID-19 in health care spaces. The following research question was taken as a starting point: what are the studies available in the literature on the use of personal protective equipment by health professionals in coping with COVID-19 in healthcare spaces?

## METHOD

It is a scope review, which structures the main conceptions of a given area of knowledge, summarizing, investigating and disseminating the data to identify gaps.<sup>6</sup> The research was conducted according to the structure of the protocol proposed by the Joanna Briggs Institute (JBI), which included the following steps: a) identification of the research objective and question; b) outline of the inclusion criteria; c) identification of search strategies; d) data extraction; e) discussion of results and conclusions, including implications for future research and practice.<sup>6</sup> The Preferred Reporting items for Systematic reviews and Meta Analyses extension for Scoping Review (PRISMA-ScR) were used to ensure the reliability of the scope review methodological processes.<sup>7</sup>

In formulating the question, the population, concept, and context (PCC) mnemonic strategy was used for a scope review.<sup>6</sup> Population (P): health professionals working at COVID-19; concept (C): use of personal protective equipment; and context (C): spaces for health care during the confrontation with COVID-19.

As inclusion criteria were chosen articles involving health professionals working in the care of COVID-19 in different contexts of health care and with a focus on the use of personal protective equipment, review articles, meta-synthesis, meta-analysis, quantitative, qualitative, and mixed, full text available in English, Spanish and Portuguese. Exclusion criteria were articles that were restricted to the physiology of other respiratory diseases, editorials, comments or without focusing on the research question.

The search was carried out on June 12, 2020, using the controlled descriptors selected in the Medical Subject

Headings (MeSH): “Personal Protective Equipment”, “Health Personnel”, “Covid-19. The descriptors and their synonyms were combined with Booleans: AND and OR to compose the search keys to be used in the databases. The databases used were the National Library of Medicine (PubMed), Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Latin American and Caribbean Literature on Health Sciences (LILACS). The search was performed simultaneously by three reviewers independently. Foram identificados 140 artigos, quatro artigos na plataforma LILACS, 101 na Pubmed e 35 na CINAHL. Publications were organized with the help of Endnote Web software and Review Manager (RyvanQCRI.org). The selection was made through a double-blind choice by the three reviewers, based on title, abstract and full text. Disagreements were resolved with the participation of a fourth reviewer (DP) for discussion and consensus. A hand search was also performed using primary articles included in the databases. The process followed the steps of PRISMA-ScR, as shown in Figure 1.

The following data were extracted from the articles included: title, author, year, objective, methodology, study setting, context, country, participants/sample, main

results, and limitations. Therefore, a table was built, which gave rise to Table 1, which supported the elaboration of the results.

## RESULTS

After the process, 19 articles were included for the synthesis of the review (Figure 1). The extracted information was compared to each other, seeking to describe the available evidence that answered the guiding question. The summary of the analysis of the data extracted from the articles is presented in Table 2.

Of the selected articles, 13 were identified as primary studies and six as theoretical studies. All published in English, in the year 2020. Table 1 presents a summary of the main characteristics of the studies.

Of the 19 eligible studies, it is observed that 11 were carried out with professionals from different backgrounds, including: physicians, nurses and Nursing technicians, pharmacists, social workers and physiotherapists, in addition to the hospital’s administrative team.<sup>2,8-17</sup> The research defined as participants any health professionals who were directly involved in the intubation process of

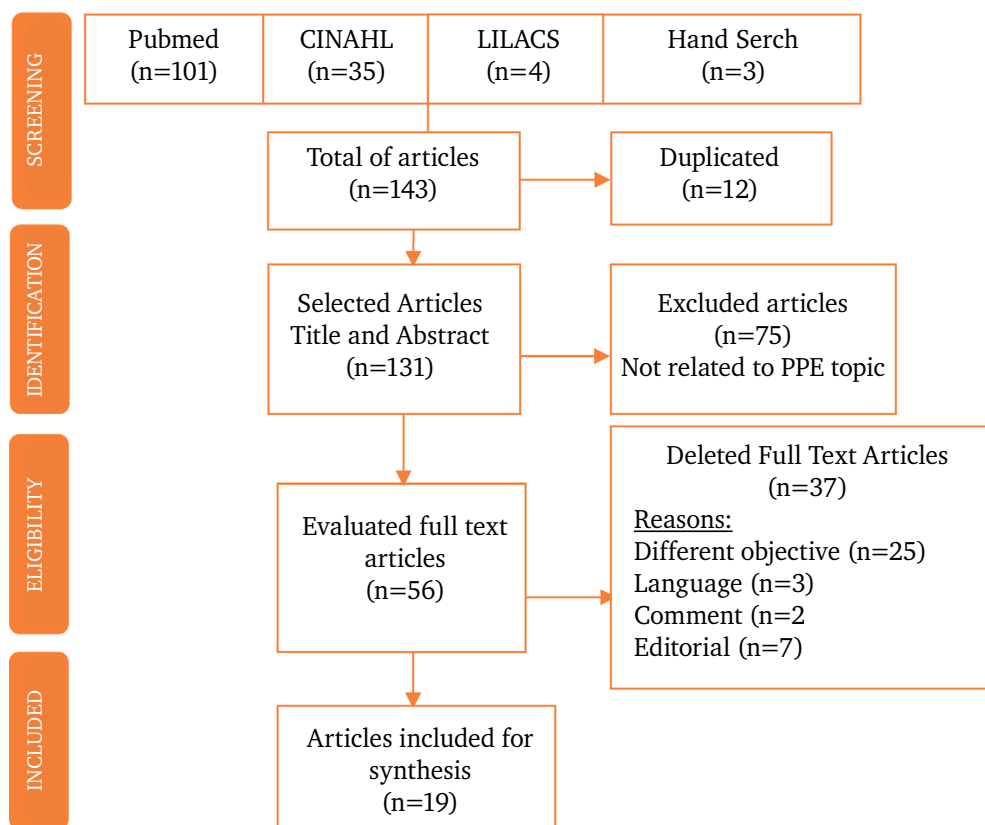


Figure 1 - Steps of PRISMA-ScR

Table 1 - Characteristics of the 19 studies in the literature scope review

Title	Objective	Method – Type of Study	Scenario/ Context/ Country	Participant/es/ Population	Focus of the EPIS in the study/Concept
<b>Primary Studies</b>					
<sup>8</sup> <i>Personal protective equipment and intensive care unit health-care worker safety in the COVID-19 era (PPE-SAFE): An international survey</i>	Describe current reported practices, availability, training, confidence in use, and adverse effects due to the extended use of PPE by healthcare professionals worldwide who care for patients with COVID-19 requiring treatment at the ICU	<i>Survey, online. Self-completion form - email invitations using mailing lists from the European, Australian and New Zealand Society of Critical Care Medicine, Australian College of Critical Care Nurses and the European Society for Clinical Microbiology and Infectious Diseases</i>	In 90 different countries, including countries in Africa, Asia, Europe, North America, Oceania and South America, all in an intensive care environment	Healthcare professionals from any discipline or background or level who are directly involved in the management of patients with COVID-19 in a critical care setting. Doctors, Nursing and other professionals. (N=2,711)	PFF2/N95 and PFF3 masks, surgical mask, long-sleeved and sleeveless waterproof aprons, lab coat, face shields/visors, eye protection, cap, double and single gloves Recommendations for PPE have varied significantly between and within countries, and the scarcity of PPE equipment has led to practices to reduce, reuse, or replace products. Most respondents reported adverse effects to the use of PPE
<sup>10</sup> <i>Impact of COVID-19 Outbreak on Healthcare Workers in Italy: Results from a National E-Survey</i>	Exhaustively explore the impact of the COVID-19 outbreak on healthcare professionals in Italy	<i>Survey, online self-completion form (BOS platform - Bristol Online Survey) - disseminated by social media (Twitter, Facebook, and LinkedIn) and by Agenzia Nazionale Stampa Associata</i>	In Italy, in hospitals and clinics (includes home care clinics, community pharmacies and health districts)	Health professionals working in Italy (doctors and other professionals such as nurses, social workers, pharmacists and hospital administrative staff) (N=388)	Gloves, masks, goggles or face shields and aprons, N95 or standard PFF2 respirators or equivalent. Most reported having access to PPE, but few considered it adequate and of good quality
<sup>2</sup> <i>Personal Safety during the COVID-19 Pandemic: Realities and Perspectives of Healthcare Workers in Latin America</i>	Assess the reality and perceptions of personal safety among healthcare professionals working in Latin American countries during the current outbreak of COVID-19	Survey, quantitative and online form - websites and social networking applications (Twitter, Instagram, Facebook, LinkedIn, and WhatsApp) and an existing database of the Inter-American Society of Cardiology (IASC)	Latin American countries in clinics and/or hospitals (Argentina, Venezuela, Costa Rica, El Salvador, Colombia, Paraguay, Uruguay, Mexico, Peru, Bolivia, Puerto Rico, Dominican Republic, Honduras, Panama, Cuba, Ecuador, Chile, Guatemala and Nicaragua)	Health professionals. Doctors, nurses, and other professionals (N=936)	Hand sanitizer gel, disposable gloves, disposable aprons, disposable masks, N95 masks and face shields. Most had access to PPE, however, there were many health professionals who did not have the equipment required and recommended by the WHO
<sup>12</sup> <i>Cognitive load and performance of health care professionals in donning and doffing PPE before and after a simulation-based educational intervention and its implications during the COVID-19 pandemic for biosafety</i>	Assess the cognitive load and performance of healthcare professionals in putting on and taking off personal protective equipment, before and after a simulation-based educational intervention	Prospective study with before and after a clinical simulation, based on two cases related to COVID-19	Clinical simulation center in the Triángulo Café region, Colombia. Two simulation scenarios were proposed, one in the emergency room and the other in the intensive care unit	Health professionals. Doctors, physiotherapists, and nurses (N=61)	Overalls, apron, N95 mask, gloves, goggles, face shield and hand hygiene. It is suggested that there is a very high risk of contamination during the act of putting on and removing the equipment and that despite the knowledge, health professionals do not carry out the proper placement and removal. The biggest difficulties were in the removal of the apron/overalls and the N95 mask

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Title	Objective	Method – Type of Study	Scenario/ Context/ Country	Participant/es/ Population	Focus of the EPIS in the study/Concept
<b>Primary Studies</b>					
<sup>18</sup> <i>Risks to healthcare workers following tracheal intubation of patients with COVID-19: a prospective international multicentre cohort study</i>	Determine the incidence and risk factors for the development of COVID-19 in healthcare workers after their involvement in tracheal intubation	Online international multicenter cohort prospective. Self-fill form - social media and national and international professional organizations	In 503 hospitals in 17 countries (European Union, United States of America, Australia, Sweden, and others)	Health professionals who performed or assisted in orotracheal intubation (N=1,718)	Lab coat, gloves, eye protection, and breathing masks certified to N95 or FFP2 or FFP3 or equivalent standard. There is insufficient use of PPE and the combinations of protective equipment varied, making it impossible to relate the use of the equipment according to WHO standards
<sup>15</sup> <i>Headaches Associated With Personal Protective Equipment – A Cross-Sectional Study Among Frontline Healthcare Workers During COVID-19</i>	To assess the prevalence and characteristics of migraines associated with exposure to PPE among healthcare professionals at our institution and to assess the impact of its use on pre-existing headache disorders	Survey, quantitative through a self-administered questionnaire. The authors involved in this study themselves were assigned to these high-risk areas during the study period and recruited participants in their respective areas.	National University Hospital (NUH), a tertiary referral center located in western Singapore. High-risk hospital areas such as isolation wards, emergency rooms and the intensive care unit	Health professionals over 21 years old, who understand the English language and work in high-risk hospital areas, such as isolation wards, emergency rooms and the intensive care unit. Nurses, doctors and paramedics (N=158)	Face shield, N95 mask and goggles. Participating professionals reported headaches associated with PPE, especially when using the N95 mask. The location of the discomfort corresponded to the contact areas of the equipment
<sup>17</sup> <i>The adverse skin reactions of health care workers using personal protective equipment for COVID-19</i>	Explore adverse skin reactions among healthcare professionals who use PPE	Quantitative descriptive research, with distribution of questionnaires	Hospitals in Hubei Province - China.	Registered health professionals, doctors and nurses; frontline workers against COVID-19; who worked in hospitals in Hubei province and those who usually use PPE (N=61)	N95 mask, latex glove and protective clothing. The most common adverse skin reactions included nasal bridge scars, itchy face, skin damage, rash, cracked skin and papules, which can be associated with prolonged use of the equipment
<sup>19</sup> <i>Risk of COVID-19 among frontline healthcare workers and the general community: a prospective cohort study</i>	Assessing the risk of COVID-19 among frontline health professionals compared to the wider community and the influence of PPE	Cohort study, online, using the smartphone app COVID Symptom Study. Recruited through social media as well as invitations from long-term cohort study researchers to study volunteers	The entire population of the UK and USA, being later divided into community and health professionals	UK and US population. The individuals were asked if they worked in the health area and, if so, the front-line health professionals were defined as participants who reported direct contact with the patient, the others were classified as community (N= 2,810,103 users, 2,627,695 in the UK and 182,408 in the US. In total there were 134,885 health professionals)	Masks, face shields, gloves and others. There is compelling evidence that availability and/or sufficient quality of PPE reduces the risk of COVID-19 infection, but reuse or misuse can pose a high risk of self-contamination during placement and removal due to prolonged wear

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Title	Objective	Method – Type of Study	Scenario/ Context/ Country	Participantes/ Population	Focus of the EPIS in the study/Concept
<b>Primary Studies</b>					
<sup>16</sup> <i>Use of personal protective equipment against coronavirus disease 2019 by healthcare professionals in Wuhan, China: cross sectional study</i>	Examine the protective effects of appropriate personal protective equipment for first-line healthcare professionals who care for patients with coronavirus disease (COVID-19)	Survey, with online questionnaire, phone call and emails. Professionals were sent to hospitals and underwent daily monitoring for symptoms related to COVID-19. They lived in designated hotels and special buses were used for transportation. Participants followed the rules of social distancing and wearing a mask in public places	Four hospitals in Wuhan (China): West Division of Union Hospital, Guanggu Division of Tongji Hospital, Hankou Hospital and Honghu Hospital	There were 420 health professionals. In hospitals located in China (Wuhan) (N= 116 doctors and 304 nurses)	Protective clothing, masks, gloves, goggles, face shields and aprons. Despite being at high risk of exposure, health professionals who were adequately protected did not contract infection or developed protective immunity against SARS-COV-2
<sup>9</sup> <i>Human Factor Considerations in Using Personal Protective Equipment in the COVID-19 Pandemic Context: Binational Survey Study</i>	Examine the main human factors (physical and ergonomic, perceptual, and cognitive) that influence the use of level 1 PPE in the care of patients with suspected or confirmed COVID-19	Survey online. Likert self-completion form on Qualtrics online platform (Qualtrics International Inc). Social media - (Facebook, WhatsApp and closed group email list)	Pre-hospital and hospital sector serving patients with COVID-19 in Israel and Portugal	Health, medical, Nursing and other professionals who provide pre-hospital and hospital care for patients with COVID-19 and using PPE level 1 (N=722 in Israel and N=301 in Portugal)	Complete PPE attire (overalls, face shield, N95 mask, eye protection, shoe covers and gloves). Agreement was high between professions and between the two countries regarding physical and ergonomic discomfort, difficulty in seeing what is going on, in hearing, in understanding speech and in understanding the situation when using PPE
<sup>14</sup> <i>Initial experiences of US neurologists in practice during the COVID-19 pandemic via survey</i>	Test the hypothesis that American neurologists were facing significant challenges from the lack of personal protective equipment (PPE)	Survey online. Auto-complete form - social media (Facebook, Twitter, Instagram) mailing list services and American Neurological Association	Practices in inpatient and outpatient settings in the US	Neurologists trained and in training (N=567)	N95 mask, apron, and gloves. Variability of protocols, availability and provision of PPE and inclusion and exclusion of trainees in the care of COVID-19
<sup>11</sup> <i>Whole-Process Emergency Training of Personal Protective Equipment Helps Healthcare Workers Against COVID-19</i>	Develop an emergency personal protective equipment (PPE) training program for general healthcare professionals (HCWs) who may be under threat from coronavirus disease 2019 (COVID-19) and evaluate the effect of the program	Simulation in specialized infectious disease wards and complete sets of training equipment. Organized training and exercises targeting highly contagious diseases. The training was divided into three sections: a) lecture and demonstration; b) simulation exercise; c) testing and evaluation. An experimental training was carried out before the large-scale training	At a clinical skills training center at the tertiary hospital designated for confirmed and suspected patients of COVID-19 in Beijing, China	Hospital health professionals, including doctors, nurses, and other personnel (pharmacists, technicians, researchers, etc.) (experimental phase: Nursing - N =31; doctors - N =2; others - N =2); (large scale phase: Nursing - N =225; physicians - N =33; others - N =5)	Work shoes, cap, N95 respirator, goggles, face shield, gloves, protective overalls, and boot cover. Hand hygiene and waste disposal were also included. Nearly three-quarters of participants failed the test before training, but all passed after training. In the pre-test, the N95 respirator was the one that lost the highest score

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Title	Objective	Method – Type of Study	Scenario/ Context/ Country	Participantes/ Population	Focus of the EPIS in the study/Concept
<b>Primary Studies</b>					
<sup>13</sup> <i>Perceived infection transmission routes, infection control practices, psychosocial changes, and management of COVID-19 infected healthcare workers in a tertiary acute care hospital in Wuhan: a cross-sectional survey</i>	Explore perceived infection routes, factors influencing psychosocial changes and management procedures for health professionals infected with COVID-19	Survey, online with self-administered questionnaire. Epidemiological data were confirmed through phone calls and checking the patients' electronic medical records to collect information about the treatment. In addition, tele-interviews were carried out with the directors of the infected department	Wuhan University Zhongnan Tertiary Hospital, China. It was divided into two groups: departments of high risk of nosocomial infection and low risk of nosocomial infection	Health professionals registered with the Division of Medical Affairs with a confirmed diagnosis of COVID-19. Doctors, nurses and medical technicians (N=103)	Mask, glove, hand hygiene, face shield, protective clothing, shoe. In a retrospective report, health professionals always strictly followed hand hygiene and the procedure for using and removing protective equipment. Most always wore a mask and gloves. A large number highlighted that they had never used a face shield, protective clothing, and shoe protectors
<b>Theoretical Studies</b>					
<sup>23</sup> <i>Facial protection for healthcare workers during pandemics: a scoping review</i>	Compile existing evidence on the use and effectiveness of alternative and medical-grade forms of facial protection for healthcare professionals amid growing global shortages	Scope review. Medline via PubMed was used as a database and gray literature was included. Published systematic reviews and meta-analyses were excluded as meta-analysis was beyond the scope of this review	Articles related to facial protection and possible adaptation strategies in the scenario of lack of PPE. Articles related to strategies for extended use, reuse, and sanitization of medical grade masks and on the efficacy and safety of alternative masks	There were 35 basic research articles, 9 clinical research and 4 secondary research. In addition, the total of 19 gray literature sources (N=67)	Face shield - surgical masks, N95 respirators and face shields. N95 respirators perform best in laboratory testing and provide superior protection in hospital and outpatient environments. Surgical mask and N95 respirator conservation strategies include prolonged use, reuse, or sanitization, but may result in inferior protection
<sup>22</sup> <i>Medical masks and Respirators for the Protection of Healthcare Workers from SARS-CoV-2 and other viruses</i>	Summarize available evidence on the use of medical masks and respirators in the context of viral infections, with a specific focus on COVID-19	Scope review. Search for articles performed in PubMed, Embase and Medline databases. A snowball search was also carried out in the references of selected articles	Pre-clinical and clinical studies on the use of medical masks or respirators in the context of viral infections by April 3, 2020	Study does not show quantity of articles found and types	Medical masks and respirators (surgical mask, N95 mask, elastomeric respirator, filtering facepiece respirator with expiratory valve, powered and air-supplied respirator, air-supplied respirator)
<sup>3</sup> <i>A rapid systematic review of the efficacy of face masks and respirators against coronaviruses and other respiratory transmissible viruses for the community, healthcare workers and sick patients</i>	Review the evidence around the effectiveness of masks and respirators for healthcare professionals, sick patients, and the general public	Quick systematic review. Articles were searched on Medline and Embase. Relevant articles were also included in the reference lists of previous clinical trials and systematic reviews. Results were reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria	Randomized controlled clinical trials on the use of respiratory protection by healthcare professionals, sick patients, and community members	The study included 19 randomized clinical trials, 8 related to the community, 6 related to medical care and 5 as source control	Surgical mask, N95 respirators and cloth mask. The use of the mask as source control brought benefits, and the continuous use of respirators during the work shift is more effective than intermittent. In healthcare settings, the use of respirators is more protective compared to surgical masks. Source control is recommended to decrease transmission

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Title	Objective	Method – Type of Study	Scenario/ Context/ Country	Participantes/ Population	Focus of the EPIS in the study/Concept
<b>Theoretical Studies</b>					
<sup>20</sup> <i>Personal Protective Equipments (PPE) - Prerequisites, Rationale and Challenges during COVID-19 Pandemic</i>	Review personal protective equipment - prerequisites, rationale, and challenges during the COVID-19 pandemic	Scope review study. The search was in electronic databases, PubMed, Science Citation Index and Cochrane, looking for studies, guidelines, reports, and policies on EPP, COVID-19 PPE, COVID-19, and respiratory infections	Scientific articles that addressed the effectiveness of personal protective equipment, knowledge, intervention, and compliance related to the proper selection and use of PPE	20 articles, 10 guidelines and 06 government reports from various health organizations were included (N=36)	PPE kit (gloves, overalls/gown, goggles, N-95 or higher efficiency masks, shoe and cap, face shield) and cloth mask. The lack of agreement in the selection and use of types of masks and respirators is reflected around the world. Applying a risk-based approach based on exposure helps with rationalization. There are several methods used to reuse the N95 mask (heat, dry, wet heat, radiation), but it is still not very effective as it reduces the filtering capacity. The cloth mask provides 67% protection and reduces virus transmission by 40%. The complete PPE kit should be used by all personnel working with patients with COVID-19. The use of personal protective equipment is only one measure within a set of actions
<sup>21</sup> <i>COVID-19 and Keeping Clean: A Narrative Review To Ascertain the Efficacy of Personal Protective Equipment To Safeguard Health Care Workers Against SARS-CoV-2</i>	Check the effectiveness of personal protective equipment to protect healthcare professionals against SARS-CoV-2	Narrative review	Narration about the effectiveness of PPE and how the available evidence can be applied to the COVID-19 pandemic and also addresses issues related to the long-term use of N95 respirators	Narration organized according to the transmission route (contact, droplets and aerosols and prolonged use of the N95 mask). Divided into initial investigations in SARS-CoV-2, retrospective studies of coronaviruses, prospective studies on influenza and other common respiratory viruses, and laboratory studies of PPE	The text discusses the use of complete EPIS (gloves, apron, eye protection, coat, cap, masks, and face shield) according to the risk of infection. Contact and droplet precautions as well as eye protection and hygiene measures are adequate in the vast majority of clinical settings when caring for patients with SARS-CoV-2
<sup>24</sup> <i>Personal protective equipment for preventing highly infectious diseases due to exposure to contaminated body fluids in healthcare (Review)</i>	Assess which type of whole-body PPE and which method of placing or removing PPE poses the least risk of contamination or infection for the healthcare professional and which training methods increase compliance with PPE protocols	Integrative review article update. Database search: Central, Medline, Embase and CINAHL. All randomized and non-randomized controlled prospective or retrospective studies were included, as well as case-control studies. Studies without a comparison group were excluded, but studies based on the type of comparison group were not excluded	Studies evaluating the effectiveness of different types of full-body protection or comparing different types, compositions or amounts of equipment. Studies that evaluated the effectiveness of different parts of PPE or different procedures or protocols for putting on and taking off PPE, and studies that evaluated the effectiveness of training in increasing compliance with existing guidelines on the selection or use of PPE	All controlled studies that evaluated the effect of full PPE worn by healthcare professionals exposed to highly infectious diseases, studies that compared ways of wearing PPE and the effects of training on the same outcomes. In the update, 24 studies were included, of which 14 were randomized controlled trials (RCT); one was quasi-randomized; and nine had a non-randomized design. Eight studies compared types of PPE; six evaluated adapted PPE; eight compared the placement and withdrawal processes; and three evaluated the types of training. Eighteen studies used simulation	Aprons, coveralls, goggles, visors, masks, or hoods that cover the entire head, gloves, and boots. Covering more parts of the body leads to better protection, but generally has a greater risk of contamination during placement or removal and more discomfort. For donning and taking off procedures, one-step glove and gown removal, double gloves, spoken instructions during takeoff, and the use of glove disinfection can reduce contamination. Training can reduce errors

Source: own authorship, 2020.



Table 2 - Characteristics of the study, Brasília, 2020

Characteristic	N
<b>Methodology</b>	
Quantitative.....	11
Mixed.....	02
Narrative Review.....	01
Scope Review.....	03
Quick Systematic Review.....	01
Integrative Review.....	01
<b>Country where the research was carried out</b>	
China.....	04
United States.....	01
Colombia.....	01
Italy.....	01
Singapore.....	01
Israel e Portugal.....	01
United States and United Kingdom.....	01
More than three countries.....	03
<b>Data Collection Scenario</b>	
Intensive Care Units.....	02
Simulation Center.....	02
Pré-Hospital and Hospital.....	02
Hospital (inpatient and outpatient).....	06
Health professionals and the community in general in the countries.....	01

patients.<sup>18</sup> Another research<sup>8</sup> chose as the population only health professionals who had already been diagnosed with COVID-19, while three addressed only health professionals who worked on the front lines of the fight against COVID-19.<sup>9,13,17</sup>

Community participation was identified in a study, which considered the population of the United Kingdom and the United States of America, defining afterwards and following research criteria which would be considered health professionals.<sup>19</sup>

The use of decontamination gel and hand hygiene was reported in three primary studies, two related to clinical simulation and one of the types of survey.<sup>11-13</sup> Variation was observed between publications in relation to the composition of the complete PPE suit. In 12 studies, complete attire was described as the concomitant use of overalls and/or protective clothing, face shield, masks - including N95 -, eye protection and gloves. The use of double gloves was considered in a survey.<sup>8</sup> Another added the shoe and the cloth mask.<sup>20</sup> There was also differentiation in the use of PPE according to the risks of infection to which professionals would be exposed, with no standardization of a kit to be used in all environments.<sup>21</sup>

One approach observed in the research studies was to target the use of some protective equipment. Three studies analyzed only equipment used for respiratory

protection.<sup>3,22,23</sup> Others also included goggles, face shields and gloves.<sup>15,19</sup> A detailed description of the function and composition of some PPE was observed in a study, which described masks PFF2/N95 and PFF3, surgical mask, waterproof long sleeve and sleeveless gowns, lab coat, face shields/visors, eye protection, cap, double and single gloves.<sup>8</sup>

Regarding the access of health professionals to personal protective equipment, the studies mostly brought reports of scarcity, reuse, poor quality of material and absence of PPE.<sup>2,8,10,14,18,19,21</sup> It was also found that health professionals who use inappropriate or reused equipment had higher rates of contamination compared to those who used it properly.<sup>14,19,21,23</sup> The constant use and risk-based approach to the equipment proved to be an important barrier in preventing the contamination of health professionals.<sup>3,20</sup>

The studies revealed that professionals have difficulties in using PPE, especially in relation to the attire (putting on) and undressing (removal) of the N95 mask and overalls.<sup>11,12,24</sup> Another highlights that most professionals did not usually wear protective clothing, face shields and footwear.<sup>13,24</sup>

Some works brought training strategies related to the use, placement, and removal of equipment. Simulation has been reported in studies that have had positive results in improving the professionals' technique.<sup>11,12,24</sup>

The prolonged use of protective equipment physically affected health professionals. The biggest difficulties reported refer to discomfort in the nasal bridge, hands, cheeks, and forehead, in addition to the high incidence of skin reactions, such as itching, acne and severe to moderate migraine.<sup>15,17</sup>

Facial itching and migraine occurred more frequently among professionals who used N95 masks for a long period (12 hours or more), as well as mentioning the areas of contact with goggles, face mask and mask straps as the most painful.<sup>15,17</sup>

In the literature, it was revealed that, in addition to physical discomfort, the use of PPE hindered hearing, speech and vision, causing problems in understanding and situational perception during prolonged and continuous use of the equipment.<sup>9,17,19</sup>

## DISCUSSION

The COVID-19 pandemic scenario stressed the importance of using personal protective equipment, highlighting the issue of availability for use, scarcity, reuse and application of protocols for use established in different world

contexts.<sup>5, 25, 26</sup> The studies bring the concept that personal protective equipment is essential in the prevention of diseases among healthcare professionals, as they provide physical barriers between the microorganism and the user, in addition to being complementary in the control of infection transmission between patients when used in conjunction with other practices. Therefore, it is extremely important to adequately protect health professionals in the fight against COVID-19 in health institutions.<sup>2, 5</sup>

According to the World Health Organization, institutions should offer, on average, for each patient per day, the amount of 25 units of surgical gowns and masks (N95, PFF2 or equivalent), a respirator, a face shield or glasses, in addition to 50 units of procedure gloves.<sup>26</sup> However, given the scarcity, these recommendations were not complied with, requiring the establishment of protocols for use and reuse that are unique to each country.<sup>10, 12, 27</sup> Thus, one of the main health problems faced by professionals on the front lines of combating COVID-19 was the risk of contamination by coronavirus.<sup>28, 29</sup>

Due to scarcity, several countries have adopted practices to reduce, reuse and replace products of lower quality and/or not approved by the manufacturers. Such practices were intended to ensure the continuity of health care, even in the face of non-evidence of the maintenance of protective efficacy, due to damage due to time of use and sealing problems.<sup>30, 31</sup>

The reuse of supplies, according to the literature, increases the chances of disease transmission, mainly due to the risk of contamination during removal and placement, in addition to the decrease in effectiveness caused by failure in fitting and wear and tear from prolonged use.<sup>12, 31</sup> In light of this reality, the reuse in a pandemic scenario of COVID-19 was described as inevitable. From this perspective, the literature highlights those practices must be established by the service/sector, based on exchange criteria, conservation, and storage requirements for equipment.<sup>21, 23, 27-29</sup>

As reduction, reuse and replacement practices, national agencies asked the hospital infection control team at each unit to create protocols in order to optimize the use of available resources. As a guideline, it was suggested that, in exceptional cases, when there were no equipment supplies, professionals could reuse the N95 respiratory protective mask or equivalent, for a period longer or more times than provided for by the manufacturer, provided it is packed in packaging not hermetically sealed. The guidance also instructs that the surgical mask should not be superimposed on the N95 mask, to avoid waste, instead they suggest the use of a face shield, which can be

disinfected after use and protects the mask against particles. The mask must always be used by the same professional, and before each use, inspect for possible damage, such as dirt, dents, creases, sealing and humidity.<sup>4, 30, 32</sup>

International bodies have suggested similar strategies, following the principle that the reduction, reuse, and replacement of products will only be necessary in cases of shortage of supplies. The differences mentioned were that prolonged use is preferable to reuse, to reduce the risk of self-contamination during removal and placement of the mask, which can be reused following the recommendations regarding possible damage. Another important observation was made in relation to the tissue mask, which should not be used by healthcare professionals who are in direct contact with patients with COVID-19 but can be used by the administrative team if the surgical mask is scarce.<sup>30</sup>

Despite some research being carried out on the maintenance of protection, it is known that factors such as the environment of use, exposure time, duration of procedures, the patient's viral load and the quality of the PPE interfere in the maintenance of its effectiveness.<sup>28, 32</sup>

Studies on reuse mask sterilization are still ongoing. As sterilization techniques, some studies suggest the methods of steam generated by microwaves, hot humid heat, ultraviolet germicidal irradiation, hydrogen peroxide steam, ozone decontamination and ethylene oxide. During the sterilization cycles, the mask deformed, and its filtration capacity was impaired. Only the hydrogen peroxide method deformed the mask after a few cycles.<sup>30</sup>

Faced with the need to reuse PPE and the search for minimizing the contamination of professionals, it became essential to carry out health training that would assist in the implementation of the proper technique.<sup>8, 33</sup> Research has shown that the improvement of the technique of use, through training, reduces the chances of contamination and increases the safety of professionals and patients.<sup>11, 12, 24</sup>

According to the literature, the use of simulation brought positive results for professionals. The Deliberate Practice in Fast Cycles (PDCR) method, which is when the participants act in a simulation scenario with repetition of tasks, was one of the techniques used for training in PPE attire and undressing.<sup>33</sup> Another resource used to aid in the attire and undressing was the two-person technique, which consists of an auxiliary professional and inspecting the other during the act of putting on and taking off the PPE, which provides confidence and security for the professionals.<sup>11, 12, 34</sup>

The risk of contamination can also be associated with the non-habitual nature of using certain types of equipment, such as protective clothing (overalls and apron), face protectors and shoes, a fact that hinders the development of the skill of dressing and undressing.<sup>13</sup> It is noteworthy that constant professional updating is necessary in any context of health care. The literature reports that professionals who do not update their practical skills over time enter into technical decline and generate deviations in the development of practical activities.<sup>33</sup> Thus, training in health services for workers is essential, especially in scenarios such as that of the current pandemic.<sup>9</sup>

It is the responsibility of health institutions, both at the primary and high-complexity levels, to carry out adequate training of professionals on the equipment to be used in each situation, dressing techniques and removal of supplies, inspection of storage and exchange as recommended of the manufacturer, in addition to the correct and safe disposal.<sup>11,35</sup>

Another important factor is the proper selection of the PPE used by workers, which must be compatible with the clinical situation of patients with COVID-19 or other infectious diseases.<sup>9</sup> It is noteworthy that the literature reveals that health professionals who use inappropriate PPE in direct contact with the patient had higher rates of risk of contamination compared to those professionals who have and properly use the equipment, that is, the incorrect use may be directly related to the increased risk of contamination.<sup>19</sup> The need to use adequate protection throughout the working period is also highlighted, including in the care of patients without suspicion of the disease and when performing procedures with low risk of infection.<sup>26</sup>

Discomfort caused by prolonged use of protective equipment and often misuse during the entire work shift can influence the practice of discontinuous use or even non-use. Occurrences of skin and mucosal lesions have been reported, related to the inappropriate and prolonged use of PPE, especially in areas of great contact, such as the nose and head.<sup>36</sup> Adverse reactions can increase the resistance of professionals to the correct use, even knowing the protocols that recommend the equipment as essential, or they can generate an erroneous association that discomfort is natural to that situation.<sup>37</sup>

Other issues identified were problems in speech understanding and listening due to the amount of protection used. A recommended strategy for minimizing these impacts is the creation of a commonly used sign language, which can be created by the team professionals themselves.<sup>38</sup>

The main limitations of the research were the few publications of national and international studies on the recent theme; constant changes in the scenario, which generate new scientific evidence from healthcare, geographic and cultural realities different from those mapped in this review; less coverage in the databases and an extended period between the search strategy and the publication of the article, taking into account that the search was carried out in the first semester of the beginning of the pandemic.

## CONCLUSION

The literature has shown that the mapping of the use of personal protective equipment by health professionals to face the COVID-19 pandemic in the context of health care should go beyond availability, with a focus on quality, form of use, and control prior diagnosis for planning the rational use of equipment and conducting research in loco, highlighting the need for other infection control measures. Further studies should focus on the strategy and prior control of the diagnosis to avoid the risk of exposure to health professionals.

Research involving studies with methodology that analyze the different variables in isolation must be carried out comparing the PPE and the different areas of use. They should consider variables such as quality, exposure time of health professionals, main adverse events resulting from use, as well as the construction and validation of protocols for use and for training in attire and non-dressing. It is necessary to involve a greater number of participants and varied methods to understand the complexity of the problem in the use of personal protective equipment in the face of COVID-19.

Worker health came into focus during the pandemic. Support, prevention, and protection measures must be adopted by health institutions, aiming at the professional's well-being, mainly in adverse scenarios such as the COVID-19 pandemic. This review allows professionals and institutions to have a compilation of information about the current situation of personal protective equipment and provides data for future research on the subject.

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