

Physical problems of prolonged use of personal protective equipment during the COVID-19 pandemic: A scoping review

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Abstract

Background: It is widely believed that using personal protective equipment (PPE) provides high levels of protection for healthcare workers (HCWs) in the fight against coronavirus disease (COVID-19). However, the long-term use of PPE is inconvenient for HCWs and may cause physical discomfort. These factors could result in poor compliance and disrupt the health and safety of HCWs, which may negatively affect the patient's safety.

Objective: This study aimed to investigate the literature for the purpose of collecting convincing evidence of HCWs' physical problems associated with PPE use during the COVID-19 pandemic.

Methods: This scoping review was conducted using PubMed, Embase, ProQuest, Science Direct, Springer, Biomed Central, and Google Scholar to identify the related literature.

Results: HCWs have experienced various physical disorders including skin, respiratory, musculoskeletal, nervous, urinary, and circulatory system problems that are associated with PPE in various body systems. Among these, skin problems were the most frequent physical problems.

Conclusions: The literature demonstrated the adverse impacts of using PPE on HCWs. Therefore, healthcare policymakers should take the appropriate measures to improve the work environment during the COVID-19 pandemic, which could consequently prevent and mitigate the adverse effects of using PPE.

KEYWORDS

COVID-19, healthcare workers, nurses, occupational health, personal protective equipment

1 | BACKGROUND

Coronavirus disease (COVID-19) declared as a pandemic by the World Health Organization (WHO) has spread dramatically worldwide, with 455,574,085 confirmed cases and 6,058,078 deaths up to March 12, 2022.^{1,2} Healthcare workers (HCWs) are at the forefront of managing the COVID-19 pandemic under challenging conditions and heavy workloads. They are more susceptible to infection and the current condition has led to

concerns over their health.³⁻⁶ A growing body of the literature has reported HCWs' high levels of physical and psychological problems resulting from caring for patients with COVID-19.⁷ Furthermore, 115,000 of HCWs passed away as a consequence of contracting COVID-19 worldwide.⁸ In addition, it is extensively believed that using personal protective equipment (PPE), including gloves, aprons, long-sleeved gowns, eye goggles, face shields (or visors), surgical masks, and respirator masks is an essential measure to prevent the spread of COVID-19.⁹ Although this

equipment provides high levels of protection for HCWs in the fight against infections such as COVID-19, in real-world practices, the use of PPE is inconvenient and cumbersome for HCWs¹⁰ and could lead to physical discomforts. If these discomforts are not properly addressed, using PPE may result in poor compliance, especially when it is used for a long time.^{9,11–15} Thus, these factors can disrupt the health and safety of HCWs, impair their physical function, and make their work more difficult, which can lead to negative consequences for the patients and even compromise their safety.¹³ Research has shown that dealing with a pandemic like COVID-19 depends on having mentally and physically healthy HCWs, which is associated with a decreased rate of transmission as well as better patient outcomes.^{7,16} Consequently, protecting the physical health and safety of HCWs is crucial for achieving better outcomes.

Although using PPE is more critical than ever, the COVID-19 pandemic has induced totally different conditions and challenges in this regard. While there have been numerous studies in this area, there is no comprehensive study in the literature that reaches an overall conclusion. Hence, the conclusions about the challenges of using PPE are not fully specified. Therefore, this scoping review intended to summarize the current evidence of physical problems associated with using PPE in HCWs working in diverse clinical contexts during the COVID-19 pandemic.

2 | METHODS

2.1 | Design

This scoping review employed Arksey and O'Malley framework.¹⁷ The findings were presented by the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).¹⁸ In this study, we followed five steps: (1) Identifying the research questions, (2) Identifying relevant studies, (3) Selecting the studies, (4) Charting the data, and (5) Collating, summarizing, and reporting the findings.¹⁷ The primary research question guiding this review was "What are HCWs' physical health problems related to the use of PPE during the COVID-19 pandemic?"

2.2 | Literature search strategies

A comprehensive literature search was conducted using PubMed, Embase, ProQuest, Science Direct, Springer, Biomed Central databases, and the search engine of Google Scholar (for the gray literature) on HCWs' physical problems related to PPE use during the COVID-19 pandemic. The search strategy aimed to find both published and unpublished literature in English from December 1, 2019 to December 31, 2020. Medical subject headings (Mesh) and relevant keywords were searched using Boolean operators

"OR/AND." The search terms were: ("COVID-19" OR "coronavirus" OR "SARS-CoV-2" OR "nCoV") AND ("healthcare workers" OR "health personnel") AND ("physical problem" OR "physical health" OR "occupational health") AND "PPE" OR "N95 respirator" OR "protective gown" OR "mask" OR "gloves" OR "aprons" OR "long-sleeved gowns" OR "eye goggles" OR "face shields (or visors)" OR "surgical masks" OR "respirator masks"). In addition, the literature-based reference lists were checked to meet the inclusion and exclusion criteria. The published literature was manually searched to identify any other source that might merit inclusion. The search strategy in the two databases of PubMed and Embase was shown in Table 1. A similar approach was taken for other databases.

2.3 | Eligibility criteria

The literature, at least English abstracts and published or in-press papers (from December 1, 2019 to December 31, 2020), on HCWs' physical problems associated with PPE use during the COVID-19 pandemic, was selected. HCWs included all clinical staff: nurses, medical doctors, allied health professionals, paramedics, and technicians. There was no limitation to the type of the literature. The literature on previous epidemics, physical problems related to PPE in the general population, nonphysical health conditions, and non-English literature were excluded.

2.4 | Identification and selection of literature

Two researchers (M. Sh. and A. P.) independently searched the literature and then selected the sources. The research results were then compared, and duplicate literature was removed. Disagreements between the two researchers were resolved by discussion, and, if necessary, the third person (N. D. N.) was consulted. Figure 1 PRISMA-ScR flow diagram shows the process of searching and selecting the literature.

2.5 | Data extraction from the literature

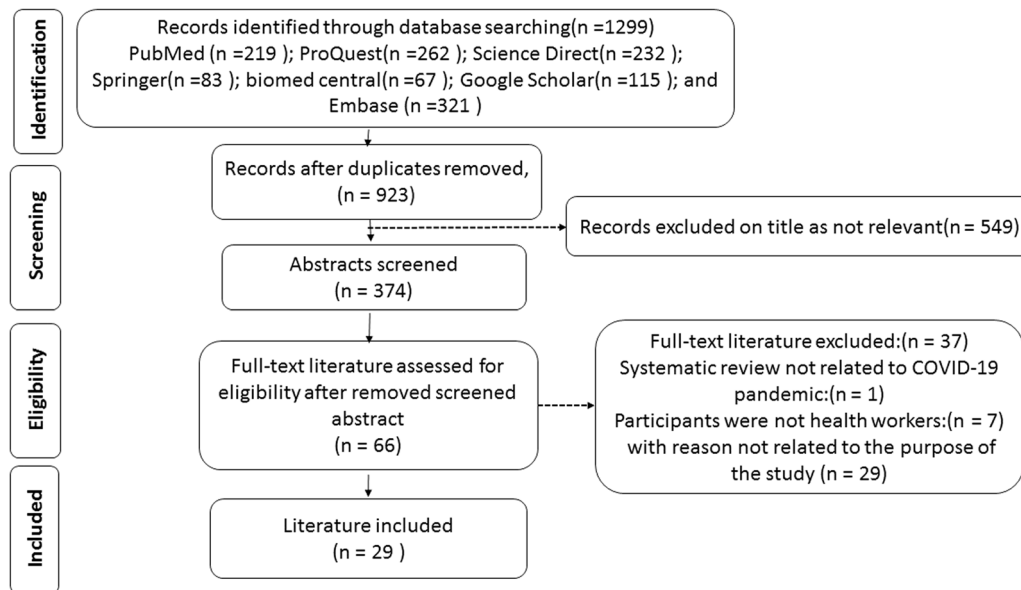
After selecting the literature, the data were extracted and recorded in tables in Microsoft Word, version 2013 (Microsoft). The main areas of concentration in the data included authors, date of publication, country, the literature type, sample characteristics, type of PPE, duration of its use, and the key findings.

2.6 | Summarizing the findings

The findings have been summarized based on the effects of physical problems associated with PPE on various body systems.

TABLE 1 Search strategy.

(((("COVID-19"[Mesh]) OR "Coronavirus"[Mesh]) OR "SARS-CoV-2"[Mesh]) AND "Health Personnel"[Mesh]) AND "Occupational Health"[Mesh]) AND "Personal Protective Equipment"[Mesh]	PubMed
(health AND personal OR (healthcare AND workers)) AND 'covid-19' AND occupational AND health AND personal AND protective AND equipment: ab, ti	Embase

**FIGURE 1** PRISMA-ScR flow diagram for database search of studies. COVID-19, coronavirus diseases; PRISMA-ScR, Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

2.7 | Characteristics of the included literature

During the initial phase of the search, 1299 sources were identified in the literature. Three hundred and seventy-six duplicate literature-based sources were excluded. Of the remaining 923 sources, 857 were excluded for irrelevant titles and abstracts. Then, the full texts of the remaining 66 sources were reviewed for eligibility. Thirty-seven literature-based sources that were not related to the COVID-19 pandemic, in which the participants were not health workers and the aims of which were unrelated to the purpose of the study were excluded. In total, 29 full-text literature-driven sources were reviewed and included in this study. Out of 29 sources, one was written in Persian; however, the abstract was English, and the author was fluent in Persian. The full text of another literature-based source was not available; however, it was selected due to its full version of the abstract and its relevance to the purpose of the study.

2.8 | Research domains

Of 29 sources selected for this review, 13 ones examined skin system problems. The remaining 16 sources assessed HCWs' various physical problems related to PPE use during the COVID-19 pandemic. The

methodological characteristics and the key findings are summarized in Table 2. The type of the literature included 10 cross-sectional studies,^{12,24–32} 1 case report,³⁴ 5 survey studies,^{13,19–22} 1 retrospective,⁹ 1 qualitative conventional content analysis,³⁵ 6 letters to the editor,^{37–42} 1 comparative observational,²³ 2 quantitative descriptive studies,^{14,33} 1 narrative review,³⁶ and 1 commentary.⁴³ From among 29 sources, 27 ones were published in 2020, and 2 were ahead of print.^{13,31} The total number of HCWs reported in the literature was 13,350. The literature population comprised male and female frontline nurses, physicians, specialist staff, midwives, laboratory assistants, paramedics, anesthesia technicians, medical staff assistants, emergency medical technicians, auxiliary support personnel, medical secretaries, physiotherapists, healthcare assistants, admin/managerial/research staff, radiographers, psychiatrists, dieticians, operations, sanitary and forensic team, medical technicians, and other clinical workers. Most of the literature-based sources were conducted in China.

2.9 | Physical problems associated with PPE use

HCWs have experienced various physical health problems associated with the use of PPE in various body systems, including the skin,

TABLE 2 Characteristics of selected literature (Research literature)

No.	References	Country	Literature type	Sample characteristics	Type of PPE and duration of use	Key findings
1	Yáñez Benítez et al. ¹⁹	26 countries from four continents: Europe, America, Asia, and Africa	Survey	N = 134 Surgical specialists and surgical trainees.	Gloves, goggles, facemask, surgical face shield, and gown.	Type of problem: Visual impairment and fatigue.
2	Davey et al. ¹³	United Kingdom	Survey	N = 224 Physiotherapists, medical groups, nurses, healthcare assistants, administrative/research, radiographers, psychiatrists, and dieticians.	Surgical mask, visor, filtering facepiece (FFP), gowns, and gloves >6 h.	Type of problem: Heat stress symptom, feel hot: 72.3%, feel uncomfortable: 89.7%, sweating: 98.7%, dizziness, fatigue, headache, contact dermatitis, reduced visibility, and discomfort in breathing.
3	Parush et al. ²⁰	Portugal and Israel	Survey	N = 1023 Physicians, nurses, paramedics, medics, and other occupations.	N95 masks, masks, goggles, face shields, gown, and gloves.	Type of problem: Physical discomfort, seeing, and hearing problems.
4	Tabah et al. ²¹	Australia	Survey	N = 2711 Physicians, nurses, and allied HCWs.	FFP2/N95 masks, surgical masks, sleeve gowns, PAPR, hazmat suit, goggles, hair cover, and face shields/visor median 4 h.	Type of problem: Heat, thirst, pressure areas, headaches, and extreme exhaustion. Site of problem:-
5	Daye et al. ²²	Turkey	Survey	N = 440 Nurse, doctor, cleaning staff, secretary, other.	PPE (masks, gloves, protective glasses, and visors).	Type of problem: Skin problems: dryness, itching, cracking, burning, flaking, acne, lichenification suggesting irritant contact dermatitis, and exacerbation of skin diseases, and previous allergies. Site of problem: Nose bridge, cheek, ear, chin, hands, forehead, and scalp.
6	Metin et al. ⁹	Turkey	Retrospective study	N = 526 Doctors and nurses.	N95 masks, masks, goggles, face shields, and gloves >8 h.	Type of problem: Xerosis or eczema, acne, redness, or erosion Site of problem: Around the nose, forehead, eyes, and ears.
7	Çiriş Yıldız et al. ¹⁴	Turkey	Quantitative descriptive	N = 553 Doctors, nurses, midwives, laboratory assistants, paramedics, anesthesia technicians, and medical staff assistant.	N95 masks, medical mask, gowns, goggles, and gloves.	Type of problem: Dryness, irritation, wound scar, pain, redness, sores, and dehydration. Site of problem: Hands, face, eyes, ears, nose, and throat.
8	Yıldız A et al. ²³	Turkey	Comparative observational	N = 48 Nurses, physicians, others (emergency medical technician, auxiliary support personnel, and medical secretary) Intervention: Prophylactic dressing on the face and nasal strip sticky.	Mask, face shield, and goggle >3 h.	Type of problem: Discomfort in breathing, skin injuries 47.9%, pressure injuries (PIs), erythema of intact skin, itching, papule, or pustule type skin lesions. Site of problem: Nasal bridge, right cheek, left cheek, forehead, chin, and posterior part of the head.

TABLE 2 (Continued)

No.	References	Country	Literature type	Sample characteristics	Type of PPE and duration of use	Key findings
9	Lee et al. ¹²	India and Singapore	Cross-sectional	N = 165 Medical groups, nurses, operations, sanitary, and others.	N95 masks, surgical masks, goggles, face shields, gown, and gloves > 6 h.	Type of problem: Symptoms associated with thermal stress: thirst, excessive sweating, exhaustion, headaches, dizziness, breathing difficulties, and dehydration.
10	Ong JY et al. ²⁴	Singapore	Cross-sectional	N = 158 Nurses, doctors, and paramedical staff.	N95 facemask and goggles > 5 h.	Type of problem: Headaches or exacerbation pre-existing headache disorders.
11	Lin et al. ²⁵	China	Cross-sectional	N = 376 Doctors and nurses.	N95 respirator, surgical masks, and double gloves.	Type of problem: Adverse skin reactions (74.5%): Most common reactions dryness or scale > papules or erythema > maceration. Site of problem: Hands, cheeks, nasal, and bridge, respectively.
12	Lan et al. ²⁶	China	Cross-sectional	N = 542 Physicians and nurses.	N95 mask, goggles, Face shield, and Gloves > 6 h.	Type of problem: Skin damage (97%), dryness and tightness (70.30%), and desquamation (61.60%). Site of problem: Nasal bridge (83.1%); hands, cheeks, and forehead.
13	Bharatendu et al. ²⁷	Singapore	Cross-sectional	N = 154 HCWs.	N95 respirator-mask alone and N95 Combined with PAPR.	Type of problem: N95 respirator-mask alone results in significant alterations in cerebral hemodynamics and headache.
14	Atay et al. ²⁸	Turkey	Cross-sectional	N = 307 Nurses.	N95 masks, surgical masks, gloves, gown, and goggles/face shields > 4 h.	Type of problem: Redness, dryness, sweating, headaches, and vision problems. Site of problem: Mouth, cheeks, nose bridge, and ears.
15	Xia et al. ²⁹	China	Cross-sectional	N = 297 Physicians, nurses, medical technicians, and other.	Mask, goggles or glasses, and glove > 6 h.	Type of problem: Physical discomfort, pressure sores, retro auricular pain, chest distress or dyspnea, thirst or dry throat, dizziness or palpitation, micturition desire, nausea or vomiting, skin damage, eczema, dry skin, and skin erosion. Site of problem: Nose, cheek, forehead, retro auricular areas, respectively.
16	Jiang et al. ³⁰	China	Cross-sectional	N = 4306 Doctors and nurses.	PPE > 4 h.	Type of problem: Skin injuries (42.8%), (PIs), moist-associated skin damage, and skin tear. Site of problem: Nose bridge, cheeks, ear, forehead, armpit, groin, hands, and extremity.
17	Kiely et al. ³¹	Ireland	Cross-sectional	N = 270 Nurse, doctor, allied health members, and healthcare assistants.	PPE.	Type of problem: Dry skin, redness, and itching, irritant contact dermatitis (ICD). Site of problem: with symptoms; hands, nose, cheeks, and forehead.

(Continues)

TABLE 2 (Continued)

No.	References	Country	Literature type	Sample characteristics	Type of PPE and duration of use	Key findings
18	Zuo et al. ³²	China	Cross-sectional	N = 404 HCWs.	N95 masks and medial masks.	Type of problem: Skin reactions: itch, redness, and rashes. Site of problem: face.
19	Hu et al. ³³	China	Quantitative descriptive	N = 61 Doctors and nurses.	N95 masks, latex gloves, and protective clothing the long period.	Type of problem: scarring, itching, dry skin, rash. Site of problem: nasal bridge and face.
20	Vidua et al. ³⁴	India	Case report	N = 5 Forensic team.	protective clothing, helmets, goggles, mask, and gloves.	Type of problem: Discomfort feeling, feeling excessively hot, nausea, headache, backache, neck spasm, fatigue, dizziness, enhanced perspiration, dyspnea, suffocation, dehydration or facial redness, and faintness.
21	Saffari et al. ³⁵	Iran	Qualitative conventional content analysis	N = 16 Nursing staff.	N95 masks and surgical masks.	Type of problem: Dehydration, ulcers, and shortness of breath. Site of problem: Nose and face.
22	Lee et al. ³⁶	Singapore	Narrative review	HCWs.	N95 mask, goggles, gloves, surgical cap, and gown >6 h.	Type of problem: Acne, skin indentations and PIs, urticaria, cheilitis, facial pigmentation, seborrheic dermatitis, frictional dermatitis, ICD, eczema flare, the flare of seborrheic dermatitis, and intertrigo. Site of problem: Nasal bridge, cheeks, neck, occiput, and toe.
23	Singh et al. ³⁷	India	Letter to the editor	Physicians, nurses, and paramedical staff.	goggles, N95 masks, and face-shield.	Type of problem: Type of dermatoses: ICD, friction dermatitis, allergic dermatitis, sweat dermatitis, facial acne, lip lick dermatitis, and pressure/friction marks/rhagades with symptoms: pruritus, erythema. Site of problem: Nasal bridge, cheeks, and chin.
24	Pei et al. ³⁸	China	Letter to the editor	HCWs.	Overalls, disposable hats, disposable surgical masks, disposable isolation clothing, N95, goggles or protective masks, and disposable gloves.	Type of problem: Erythema, prurigo, bulla, papule/edema, exudation/dryness, and lichenification. Site of problem: face, hands, legs, trunk, and the whole body.
25	Yin et al. ³⁹	China	Letter to the editor	-	N95 mask.	Type of problem: Pressure sore. Site of problem: Nose bridge.

TABLE 2 (Continued)

No.	References	Country	Literature type	Sample characteristics	Type of PPE and duration of use	Key findings
26	Atzori et al. ⁴⁰	Italy	Letter to the editor	HCWs.	Masks and goggles >6 h.	Type of problem: facial dermatitis, hands contact dermatitis, contact dermatitis, skin injuries, dryness, itching, stinging sensations, pressure erythema, eczematous lesions, acneiform eruptions. Site of problem: Nasal bridge, hands, cheek, periorcular, and perioral, and zygomatic.
27	Ferguson et al. ⁴¹	United Kingdom	Research letters	The administrative, allied health professional, doctor, healthcare assistant, nurse, pharmacist, support (porter/cleaner), and other.	FFP3 mask, medical mask, gloves.	Type of problem: Hand dermatitis, facial dermatoses, atopic eczema, occlusive acne, pressure urticaria, rosacea, atopic dermatitis, ICD, and psoriasis. Site of problem: Hands and face.
28	Zhang et al. ⁴²	China	Letter to the editor	HCWs.	N95 masks, goggles, and face shields >8 h.	Type of problem: Blisters, itching, sweating dermatitis, folliculitis, fungal infections, skin injuries, lesions, and erosions. Site of injury: Feet, the forehead, nasal bridge, and zygomatic bone.
29	Long et al. ⁴³	China	Commentary	HCWs.	Gloves, masks, goggles, protective clothing and coveralls, rubber boots, and shoe covers.	Type of problem: Skin Injury, skin maceration, secondary superficial fungal infection, pompholyx, itching, tingling or burning, indentations, frictions and scratches, allergic contact dermatitis, and acne. Site of problem: Hands and feet, cheeks, nose, and ears.

Abbreviations: HCWs, healthcare workers; PPE, personal protective equipment.

*greater-than sign

respiratory, musculoskeletal, nervous, urinary, and circulatory systems. Skin problems were the most frequent ones. PPE included surgical or medical masks, N95 masks, gowns, gloves, glasses, face shields, visor, filtering facepiece, and goggles to prevent COVID-19 in the workplace. The physical health problems are shown as follows.

2.10 | Skin problems

A variety of skin system problems were experienced by HCWs due to the long-term use of PPE. These problems manifested themselves with symptoms of eczema, acne, occlusive acne, rosacea redness or erosion, dryness, irritation, scar, skin injuries, pressure injuries, erythema of intact skin, itching, papule or pustule type skin lesions, maceration, flake, tightness, pressure urticarial, rash, acneiform eruptions, blisters, folliculitis, skin indentations, eczema flare, the flare of seborrheic dermatitis, intertrigo, cheilitis, facial pigmentation moist-associated skin damage, cracking, lichenification, exacerbation of skin diseases and previous allergies, psoriasis, skin maceration, pompholyx, bulla, edema, exudation, tingling or burning, frictions, scratches, and skin tear.^{9,13,14,22,23,25-32,34-44} These symptoms suggested a variety of dermatitis: Irritant contact dermatitis (ICD),^{22,31,36,37,41} friction dermatitis,^{36,37} allergic dermatitis,^{37,43} sweat dermatitis,^{37,42} facial dermatitis,^{40,41} lip lick dermatitis,³⁷ hands contact dermatitis,^{40,41} seborrheic dermatitis,³⁶ atopic dermatitis,⁴¹ contact dermatitis,^{13,40} and fungal infections,⁴² secondary superficial fungal infection.⁴³ The areas around the nose, forehead, eyes, or ears, face, hands, cheeks, nasal bridge, chin, back of the head, neck, occiput, toe, feet, legs, trunk, armpits, groin, scalp, periocular, and perioral regions were the most commonly affected sites.^{9,14,22,23,25,26,28-30,34-44}

2.11 | Circulatory system problems

The symptoms of circulatory system problems associated with using PPE in HCWs included dehydration,^{12,14,34,35} dry throat and mouth,²⁹ exhaustion, thirst,^{12,21,29} feeling excessively hot, sweating,^{12,13,28,34} fatigue,^{19,34} feeling uncomfortable, physical discomfort,^{21,29,34} faint,³⁴ palpitation, and nausea or vomiting.²⁹

2.12 | Respiratory system problems

HCWs reported respiratory problems such as discomfort in breathing,^{12,14,23} shortness of breath,³⁵ distress, dyspnea, and suffocation.^{29,34}

2.13 | Musculoskeletal system problems

Various problems of the musculoskeletal system in form of backache, neck spasm, and retro auricular pain were experienced by HCWs.^{14,29,34}

2.14 | Nervous system problems

Nervous system problems associated with the use of PPE that were experienced by HCWs included alterations in cerebral hemodynamics,²⁷ headaches or exacerbated pre-existing headaches,^{12,13,24,27,34} dizziness,^{12,13,29} reduced visibility, visual impairment,^{13,19,20,28} and hearing problems.²⁰

2.15 | Urinary system problems

HCWs experienced urinary system problems such as micturition desire.²⁹ This case was reported in only one survey-based study.

3 | DISCUSSION

This review gathered evidence on the HCWs' physical problems related to the prolonged use of PPE during the COVID-19 pandemic. The findings from this scoping review provided further evidence and confirmed the susceptibility of HCWs to a wide range of physical problems associated with the use of PPE during the COVID-19 pandemic. The findings demonstrated that HCWs struggle with various physical health problems, including skin damages, dehydration, pain, respiratory problems, visual and hearing problems, heat stress, dizziness, fatigue, feeling uncomfortable, physical discomfort, exhaustion, enhanced perspiration, alterations in cerebral hemodynamics, palpitation, micturition desire, nausea, or vomiting. The most remarkable problem emerged from the reviewed literature was skin damage. In this regard, the nasal bridge, hands, and cheeks were reported as the most vulnerable injury sites. We identified several risk factors including long-hour shifts, extremely hot working conditions, and prolonged use of PPE, especially the frequent use of masks, gloves, and goggles. It seems, one reason for common skin problems is that most studies in the literature merely addressed skin problems.

Since HCWs are at high risk for exposure to COVID-19, using PPE such as a proper mask or a powered air-purifying respirator, eye protection, gown, gloves, and aprons is inevitable as it plays an essential role in preventing infection.^{37,38} However, the use of PPE may cause adverse physical health problems. These findings are consistent with the previous studies during severe acute respiratory syndrome (SARS) spread. In this regard, Foo et al.⁴⁵ reported that long-term use of PPE was associated with a high rate of adverse skin reactions. Furthermore, according to a systematic review, the use of personal facial protective equipment could lead to allergic and ICD, followed by acneiform eruptions and contact urticaria, especially during the periods of increased and prolonged use.⁴⁶ The problems and side effects associated with prolonged use of PPE have been addressed generally in the growing body of literature. Accordingly, headache, light-headedness, pain behind the ear or other contact points, skin damage, including acne, sore nasal bridges, itchy face, rash/irritation, discomfort related to skin temperature, difficulty in

breathing, and discomfort when speaking had been reported in various studies before the emergence of the COVID-19 pandemic.⁴⁷⁻⁵³ In line with the findings, Chughtai et al.⁵⁴ identified common problems associated with using various types of PPE, such as breathing problems, feelings of suffocation, heat stresses, hearing problems, inconveniences, and foggy glasses.

Furthermore, it was found that HCWs suffered from significant physical discomforts related to the use of PPE, such as fatigue and overwhelm,⁵⁵ sweating, dizziness, dehydration, irritation, back pain,⁵⁶ which was believed to lead to their reduced tendency to wear PPE for an extended period of time.¹⁵ Consequently, based on the results of this review, we concluded that wearing PPE under prolonged and stressful working conditions and experiencing a wide range of physical problems may impact HCWs' compliance with safety protocols.

According to the previous studies, a significant positive correlation was found between the number of physical complaints and the attitudes towards PPE use.^{13,14} Several studies have shown that PPE-induced physical problems lead to impaired physical function, difficulty at work, impaired communication with patients and colleagues, and a negative impact on the productivity of health workers.^{12,13,19,20} Similarly, in a study conducted by Houghton et al.,⁵⁵ it was determined that patients' feelings of isolation, fear, or stigma could lead to decreased usage of PPE by HCWs. However, it should be considered that the appropriateness of size, fitness, and quality of PPE is known as the main reason for promoting and encouraging elements of using PPE.

4 | STRENGTH AND LIMITATION

This scoping review has applied a systematic and vigorous search strategy to fulfill the purpose of the study. It provides a summary of recent scientific evidence that can strengthen the response to the current and future outbreaks. However, this review has several limitations. This review only included the English studies and excluded the studies published in other languages. Furthermore, it is worth mentioning that we considered both the advantages and disadvantages of Google Scholar as a search engine. From a positive perspective, it allows us to retrieve the full-texts as well as the gray literature from various websites. From a negative perspective, search algorithms change daily, and since journals are not indexed, it is challenging to reproduce any search, which is considered as a limitation. Other databases were searched to compensate for this restriction.

5 | IMPLICATIONS FOR PRACTICE AND SUGGESTIONS FOR FUTURE RESEARCH

One of the world's significant challenges in managing a crisis such as the COVID-19 pandemic is establishing appropriate approaches to protect HCW's health. It should be considered that supporting and maintaining HCW's health status is of great significance since it is

critical to the overall health of the community. Although COVID-19 will eventually be controlled and even ended worldwide, the world will likely face a new pandemic in the future, and any improvement in PPE will be significant and beneficial to the global health. It seems that due to a large number of nurses, compared to other health workers, and their long-term presence in patients' bedsides to provide care, they mostly experience health problems associated with using PPE. Consequently, the results of this study can make hospital officials and health policymakers, especially nursing managers, more sensitive to the occupational hazards associated with PPE and highlight the importance of developing strategies to mitigate these complications. Moreover, the results of this study could help the nurse managers to take appropriate measures to improve the work environment of the nurses to provide their safety and satisfaction so that they can deliver safe and high-quality care for the patients. Implementing strategies such as adjusting shorter shifts to reduce PPE use, developing updated, high-quality, and more comfortable PPE designs to reduce these problems, and increasing the well-being of HCWs, performance, and patient care outcomes could be fruitful and practical.

Furthermore, from among the research studies explored in this review, there was only one interventional research study. Also, most of the literature has been reported from Asia. Accordingly, it is recommended that the studies with more appropriate designs (e.g., cohort studies and interventional studies) further investigate the leading causes of physical problems related to PPE and the factors affecting the reduction of these problems in different parts of the world due to the different contexts and facilities required for the fight against COVID-19.

6 | CONCLUSIONS

Given the vital role of HCWs in providing care to COVID-19, they are pushed to use PPE for long hours in harsh conditions that expose them to numerous physical problems. Adverse conditions among HCWs due to PPE use are varied. Despite emphasizing the need to use PPE in the fight against COVID-19, the literature demonstrated the adverse impacts of using PPE on HCWs. Therefore, healthcare policymakers should take the appropriate measures to improve the work environment during the COVID-19 pandemic, which could consequently prevent and mitigate the adverse effects of using PPE.

AUTHOR CONTRIBUTIONS

The idea for the article provided by (Arpi Manookian and Mehraban Shahmari), The literature search, data analysis, and developing the first draft of the manuscript Performed by (Arpi Manookian and Mehraban Shahmari), and all the authors drafted and critically revised the work (Arpi Manookian, Mehraban Shahmari, and Nahid Dehghan Nayeri) and all the authors approved the final version for publishing.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Physical problems of prolonged use of personal protective equipment during the COVID-19 pandemic: A scoping review (NF-06-21-RVM-1789.R1) are available from the corresponding author (Mehraban Shahmari) request.

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