Acceptability of N95 Respirators Among Healthcare Workers

An Overview of Systematic Reviews

Date of Literature Search: 2/2/2026
Date of Submission: 3/31/2026

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Suggested citation: Mora-Moreo L, Villatoro-Rodríguez SN, Diaz-Villero JC, Vélez-Marín VM, Mahood Q, Muller MP, Florez ID. Acceptability of N95 Respirators Among Healthcare Workers.

Land Acknowledgement(s)

SPOR Evidence Alliance operates from the St. Michael's Hospital, Unity Health Toronto which is located on the traditional land of the Huron-Wendat, the Seneca, and the Mississauga's of the Credit. Today, this meeting place is still the home to many Indigenous people from across Turtle Island. We are grateful to have the opportunity to work on these lands.

Funding Acknowledgement(s)

The Strategy for Patient-Oriented Research Evidence Alliance (SPOR EA) is supported by the Canadian Institutes of Health Research (CIHR) under the Strategy for Patient-Oriented Research (SPOR) initiative.

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Abbreviations and Definitions

Abbreviations

AHS	Alberta Health Services
AMSTAR 2	A MeaSurement Tool to Assess systematic Reviews
BCCDC	British Columbia Centre for Disease Control
CDC	United States Centers for Disease Control and Prevention
CI	Confidence Interval
CINAHL	Cumulative Index to Nursing and Allied Health Literature
COVID-19	Coronavirus disease 2019
DRPIs	Device-Related Pressure Injuries
EFRs	Elastomeric facepiece respirators
ECDC	European Centre for Disease Prevention and Control
FFP	Filtering Facepiece
FFR	Filtering Facepiece Respirator
GRADE	Grading of Recommendations, Assessment, Development and Evaluation
HCWs	Healthcare workers
INSPQ	Institut national de santé publique du Québec
MERS	Middle East Respiratory Syndrome
NIOSH	National Institute for Occupational Safety and Health
NMA	No meta-analysis conducted
NA	Not applicable
OR	Odds Ratio
PRESS	Peer Review of Electronic Search Strategies
PPE	Personal Protective Equipment
PICOS	Population–Intervention–Outcome–Study Design
PAPRs	Powered air-purifying respirators
PRIOR	Preferred Reporting Items for Overviews of Reviews
PHO	Public Health Ontario
RPE	Respiratory Protective Equipment
SAG	Scientific Advisory Group
SARS	Severe Acute Respiratory Syndrome
SII	Speech Intelligibility Index
SD	Standard Deviation
WHO	World Health Organization

Key Definitions:

Acceptability: for the purposes of this review, acceptability is conceptualized as a multi-dimensional construct reflecting the extent to which healthcare workers (HCWs) perceive the use of N95 respirators as appropriate, based on their cognitive and emotional responses, as well as their experienced physical effects during use.

Adherence: the extent to which HCWs consistently wear N95 respirators as recommended during patient care activities.

Attitudes: favorable or unfavorable evaluations toward respirator use.

Burden: perceived effort required to use N95 respirators, including physical, cognitive, and operational demands. It is considered a key component of acceptability and may influence both adherence and sustained use.

Communication and speech-related effects: changes in voice quality or acoustic properties associated with respirator use. Communication difficulties referred to challenges in verbal interaction with patients or colleagues, including reduced speech intelligibility or the need for repetition.

Compliance: the degree to which HCWs correctly follow institutional protocols for N95 use, including donning, doffing, and fit checking.

Contextual factors (determinants of use): external conditions influencing the acceptability and use of N95 respirators, including duration of use, work intensity, environmental conditions (e.g., temperature), availability of equipment, and institutional policies.

Discomfort: a subjective physical or psychological unpleasant experience associated with respirator use, including sensations such as pressure, heat, breathing difficulty, or irritation. Discomfort may contribute to reduced acceptability and adherence but is conceptually distinct from clinically defined adverse events.

Elastomeric facepiece respirators (EFRs): are reusable devices with a rigid or flexible facepiece and replaceable filters. They typically include an exhalation valve and require cleaning and maintenance between uses.

Healthcare settings: any organized environment in which health services are delivered by trained personnel, including but not limited to hospitals, outpatient clinics, primary care centers, emergency departments, long-term care facilities, and dental practices.

Healthcare workers (HCWs): individuals working in healthcare settings who may be exposed to patients, infectious agents, or clinical environments, including both clinical and non-clinical staff involved in patient care or healthcare operations.

Filtering facepiece respirators (FFRs): are disposable, tight-fitting respirators made of filtering material. In Europe, they are classified as FFPs (e.g., FFP1, FFP2, FFP3) based on filtration efficiency, with FFP2 broadly equivalent to N95 respirators. Equivalent standards include N95 (NIOSH, United States), FFP2 (European Union), and KN95 (China), which offer comparable levels of filtration efficiency (≥94–95%) despite differences in certification requirements**.**

Fit testing and correct use: procedures used to ensure that a respirator forms an adequate seal with the wearer's face. Correct use encompassed adherence to recommended practices, including proper fit, positioning, and handling of the respirator.

Knowledge: the level of understanding that healthcare workers have regarding the correct use, effectiveness, and indications of N95 respirators.

N95 respirators: a disposable, tight-fitting filtering facepiece respirators (FFRs) designed to achieve a close facial seal and to filter at least 95% of airborne particles with a median diameter of ≥0.3 μm, including bacteria and viruses, when properly fitted to the wearer's face

Perceptions: referred to subjective interpretations, such as perceived risk of infection, perceived effectiveness, or perceived comfort.

Personal protective equipment (PPE): specialized clothing or equipment worn by healthcare workers to reduce exposure to health and safety risks, including infectious agents. In healthcare settings, PPE may include respirators (e.g., N95), surgical masks, gloves, gowns, and eye protection.

Psychological and cognitive effects: psychological and cognitive effects include perceived stress, mental fatigue, somnolence, reduced morale, perceived increased workload, communication difficulties, and potential impacts on task performance associated with N95 respirator use.

Physical health effects: physical health effects refer to the physiological and bodily responses associated with N95 respirator use. These include, but are not limited to, headache, facial pain or pressure, bruising, skin reactions or irritation (including contact dermatitis), heat and humidity buildup, shortness of breath, and fatigue.

Powered air-purifying respirators (PAPRs): use a motorized system to draw air through filters and deliver it to a headpiece. They may be tight-fitting or loose-fitting and reduce breathing resistance, although they require battery power and maintenance.

Recommendation: the endorsement of N95 respirator use to others (e.g., patients, colleagues, or within professional guidance), regardless of the individual's own behavior.

Subjective symptoms: self-reported symptoms such as headache, dizziness, or lightheadedness that may affect continued use and perceived burden of the intervention.

Surgical mask (medical mask): disposable medical device composed of multiple layers of nonwoven material, designed to cover the nose and mouth and act as a barrier to large respiratory droplets, splashes, and sprays. It is intended primarily for source control and to protect the surrounding environment, and does not provide a tight facial seal or reliable protection against airborne particles.

Tolerability: the ability of HCWs to wear N95 respirators for the required duration without experiencing significant discomfort or distress.

Usability: the extent to which N95 respirators can be effectively and efficiently used by healthcare workers in real-world settings, including aspects such as ease of use, fit, comfort, and integration into routine clinical tasks.

Use, intention to use: use (or actual use) referred to the reported or observed behavior of wearing N95 respirators in practice. Intention to use referred to the stated willingness or preference to use N95 respirators.

EXECUTIVE SUMMARY

Objectives: To systematically identify, critically appraise, and synthesize existing systematic reviews examining the effects of N95 respirator use on the physical and psychological health of healthcare workers (HCWs), the factors that influence acceptability and adherence, and associated adverse outcomes.

Design: Overview of systematic reviews

Method: A comprehensive literature search was conducted in MEDLINE (Ovid), Embase (Ovid), the Cochrane Database of Systematic Reviews, and Cumulative Index to Nursing and Allied Health Literature CINAHL (EBSCO), supplemented by grey literature searches of national and international public health agency websites and systematic review registries (PROSPERO and Epistemonikos). Reference lists of included reviews were also screened. Eligible publications were systematic reviews and meta-analyses addressing N95 respirator use in HCWs, published in English or French from 2015 to the date of search execution. Titles, abstracts, and full texts were screened independently by two reviewers; data were extracted using a standardized, pilot-tested form and verified by a second reviewer. Methodological quality was assessed using AMSTAR 2. Findings were synthesized narratively, consistent with Cochrane guidance for overviews of reviews.

Results: 31 systematic reviews were included (2020–2025), covering HCWs across acute care, primary care, and dental settings, predominantly in the context of COVID-19. In total, 77% of reviews (n=24) were rated critically low; six were rated low; one (Jefferson 2023) was rated High. The most common weaknesses were absent pre-registration and failure to assess or account for risk of bias in primary studies.

Acceptability: N95 respirator adherence was significantly lower than for surgical masks (pooled OR 1.26; 95% CI 1.08–1.46). Self-reported compliance with standard N95 respirator protocols was as low as 57%, versus 82% with targeted fit-tested strategies. Among dental HCWs, 70.3% endorsed N95 respirator use but only 37.7% wore one — a gap exceeding 30 percentage points, with North America showing the largest absolute gap (67.8% endorse, 16.4% use).

Physical effects: Headache affected approximately 48% of N95 respirator users (pooled prevalence 48.3%; 95% CI 40.2–56.3%). Dermatological adverse effects — pressure injuries, contact dermatitis, acne — were reported in up to 97% of frontline HCWs. Four hours of continuous use was associated with headache onset; six hours with significantly elevated skin injury risk.

Psychological and cognitive effects: Stress increased significantly beyond eight hours of mask use. Communication difficulties were reported by 20–30% of users and were most pronounced in operating theatre and pediatric settings.

Context: Variation in acceptability was driven primarily by duration of continuous N95 respirator use rather than the specific pathogen, with adverse effects such as headache and skin injury emerging after prolonged use (e.g., ≥4–6 hours). Findings were consistent across diverse outbreak contexts (e.g., COVID-19, SARS, MERS, and influenza) and settings, despite substantial heterogeneity in study designs and populations. HCWs with prior PPE experience were reported to adapt more readily.

Evidence from influenza-season randomized trials further suggests that the acceptability gap between N95 respirator and surgical masks predates COVID-19.

Conclusion: N95 respirator acceptability among HCWs appears consistently lower than that of surgical masks, driven by physical discomfort and adverse events rather than attitudinal resistance. The evidence supports action on: (1) rest break policies anchored at 4-hour (headache) and 6-hour (skin injury) thresholds; (2) mandatory fit testing and repeated training; (3) procurement criteria that include acceptability alongside filtration performance; and (4) equitable PPE provision as a prerequisite for effective respiratory protection programs.

Protocol/Topic Registration: CRD420261308402

Introduction

Healthcare workers (HCWs) face significant occupational exposure to airborne infectious agents, and the N95 filtering facepiece respirator (FFR) — certified by the National Institute for Occupational Safety and Health (NIOSH) to filter at least 95% of airborne particles — represents the standard of care for respiratory protection in high-risk clinical settings (1,2). Their use became widespread during the Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) outbreaks and reached an unprecedented scale during the COVID-19 pandemic, placing HCWs in a position of sustained, prolonged daily respirator use (1,3). However, the protective efficacy of N95 respirators is contingent on consistent and correct use, and this is fundamentally dependent on their acceptability to the HCWs who wear them. Studies have consistently documented that prolonged N95 respirator use is associated with significant discomfort, leading to improper doffing, reduced compliance, and ultimately elevated infection risk among non-adherent users (3,4). Understanding what drives or undermines acceptability is therefore not merely a matter of occupational comfort — it is a patient safety imperative.

The physical consequences of N95 respirator use are among the primary determinants of acceptability. The tight facial seal — essential for adequate filtration — creates a dead space in which CO_2 accumulates, provoking hypercapnia and hypoxia that increase respiratory rate, cardiac output, and the work of breathing (4,5). Commonly reported physical symptoms — including headache, lightheadedness, dyspnea, fatigue, and difficulty communicating — worsen with duration of use and are strongly associated with non-compliance (4,5). Dermatological adverse effects compound this burden: pressure injuries at the nasal bridge, contact dermatitis, acne, and skin barrier disruption from friction and moisture have been reported in up to 97% of frontline HCWs in some studies (6–8). These skin reactions present a particular clinical dilemma, as topical treatments may compromise the facial seal, creating a direct tension between managing adverse effects and maintaining respiratory protection (8).

Beyond physical discomfort, the psychological burden of N95 respirator use — including sensations of breathlessness, claustrophobia, and anxiety associated with prolonged tight-fitting wear — further undermines acceptability (5,8). The scale of psychological distress among HCWs during COVID-19 was substantial (47% burnout, 38% anxiety, 34% depression in a pooled analysis of over 340,000 workers) (9), and prolonged respirator use is recognized as one of several occupational stressors contributing to this burden. Acceptability is also shaped by a range of contextual factors including respirator fit, shift duration, ambient temperature, task intensity, training, and access to adequate rest breaks — all of which interact with the physical and psychological effects of prolonged N95 respirator use to determine whether HCWs can and will adhere to respiratory protection requirements (3,4). Despite this, N95 respirators are widely regarded as providing superior protection compared to surgical masks, particularly for aerosol-generating procedures, meaning that improving their acceptability — rather than abandoning their use — remains a key public health priority (4,9).

Multiple systematic reviews have examined overlapping aspects of this topic — including physical effects, adverse events, and comparative effectiveness — yet their findings vary and a rigorous higher-order synthesis that consolidates and critically appraises this body of review-level evidence is lacking (10,11). The objective of this overview of reviews is *to systematically identify, critically appraise, and synthesize existing systematic reviews examining the effects of N95 respirator use on the physical and psychological health of healthcare workers, the factors that influence acceptability and adherence, and associated adverse outcomes*, in order to provide a comprehensive evidence summary to inform occupational health policy and clinical practice.

Methods

Study design

This study was conducted as an overview of systematic reviews, following the methods outlined in Chapter V (Overviews of Reviews) of the Cochrane Handbook for Systematic Reviews of Interventions (12), and it's reported in accordance with the Preferred Reporting Items for Overviews of Reviews (PRIOR) statement (13). An overview of reviews is a synthesis designed to systematically identify, appraise, and synthesize findings from existing systematic reviews addressing a defined question, providing a comprehensive map of the available review-level evidence. This design was selected because multiple systematic reviews have examined overlapping aspects of N95 respirator use in HCWs, and a higher-order synthesis is needed to consolidate and critically evaluate this body of evidence. The overview was not restricted by geographic location or pathogen type; reviews addressing any infectious agent were eligible, provided the population comprised healthcare workers (HCWs) and the intervention was the N95 respirator. This overview was registered in PROSPERO prior to data collection on Feb 13, 2026, (registration number: CRD420261308402).

Eligibility Criteria

Eligibility was defined using a Population–Intervention–Outcome–Study Design (PICOS) framework.

Population
Systematic reviews were eligible if they included HCWs working in any clinical setting, including acute care and long-term care facilities, primary care, and dental settings. No restrictions were applied based on professional roles, seniority, or geographic location. Reviews that exclusively examined non-healthcare populations (e.g., community members, industrial workers) were excluded.

Intervention
The intervention of interest was the N95 respirator, defined as a disposable, tight-fitting filtering facepiece respirator (FFR) designed to filter at least 95% of airborne particles with a median aerodynamic diameter of ≥0.3 μm, when properly fitted to the wearer's face. Reviews were eligible regardless of N95 model, brand, or equivalent standard (e.g., FFP2, KN95), provided the device met the 95% filtration threshold. Reviews examining powered air-purifying respirators (PAPRs), elastomeric respirators, or surgical masks as the primary intervention were excluded, unless they included a distinct N95 respirator arm from which data could be extracted separately.

Comparator
Any comparator

Outcomes
Reviews were eligible if they reported on one or more of the following outcomes:

- Acceptability of N95 respirators, defined as a multi-faceted construct reflecting the extent to which HCWs consider their use to be appropriate, based on anticipated or experiential cognitive, emotional, and physical responses, encompassing HCWs' willingness to wear, tolerance of, and subjective experience with N95 respirators in clinical practice. This included, but was not limited to, measures of comfort, discomfort, and user preference.
- Physical health outcomes, including headache, facial pain, skin bruising, pressure injuries, contact or irritant dermatitis, heat and humidity buildup, shortness of breath, dyspnea, and

fatigue attributable to N95 respirator use.
- Psychological and cognitive outcomes, including stress, mental fatigue, somnolence, reduced morale, communication difficulties, impaired cognitive performance, and perceptions of increased workload associated with N95 respirator use.
- Adherence, compliance, and tolerability defined, respectively as: (i) the extent to which HCWs consistently wear N95 respirators as recommended during patient care; (ii) adherence to institutional protocols for correct donning, doffing, and fit checking; and (iii) the ability to endure N95 respirator use for the required duration without significant physical or psychological distress.
- Reviews reporting only on the infection prevention efficacy of N95 respirators, without data on any of the above outcomes, were excluded.

Study Design
Only reviews conducted using systematic methods were eligible for inclusion. This included systematic reviews with or without meta-analysis, scoping reviews, umbrella reviews, and rapid reviews that reported a systematic search and explicit eligibility criteria. Narrative reviews, commentaries, editorials, and primary studies were excluded. There were no restrictions on the study designs included in eligible systematic reviews (e.g., randomized controlled trials, observational studies, and qualitative studies).

Publication Language and Date
Eligible publications were limited to those published in English or French, from 1 January 2015 to the date of search execution (02/06/2026). This date of restriction was applied to capture contemporary evidence relevant to current healthcare practice and infection prevention contexts.

Information Sources

Bibliographic Databases
A comprehensive literature search was conducted in the following electronic databases: MEDLINE (Ovid), Embase (Ovid), Cochrane Database of Systematic Reviews (Ovid), and CINAHL (EBSCO)
Grey Literature
To capture non-indexed and policy-relevant evidence, grey literature searches were conducted across national and international public health agency websites and systematic review registries, including:
- *Canadian public health agencies*: BC Centre for Disease Control (BCCDC), Alberta Health Services (AHS), Public Health Ontario (PHO), and Institut national de santé publique du Québec (INSPQ)
- *International public health agencies:* World Health Organization (WHO), European Centre for Disease Prevention and Control (ECDC), United States Centers for Disease Control and Prevention (CDC), Australian Government Department of Health, Disability, and Ageing, and the United Kingdom National Health Service (NHS)
- *Systematic review registries*: PROSPERO and Epistemonikos

Reference lists of all included reviews were also screened to identify additional relevant evidence through a snowballing approach.

Search Strategy and Execution
Search strategies were developed by an experienced librarian in systematic review methodology. Controlled vocabulary (MeSH terms for MEDLINE and Emtree terms for Embase) and free-text terms related to N95 respirators, HCWs, and systematic review methodology were combined using Boolean operators (AND, OR). Search filters developed by the Canadian Drug Agency were applied to limit retrieval to systematic reviews. Searches were conducted on February 6, 2026 and limited to English

or French publications from 2015 to 2026. Searches were not restricted by pathogen or geographic setting. The strategy was peer-reviewed for accuracy and completeness prior to execution, in accordance with the Peer Review of Electronic Search Strategies (PRESS) guidelines (14). Targeted grey literature searches were also conducted by the same librarian in February 2026. Full search strategies are provided in **Appendix 1.**

Study Selection

All records identified through database and grey literature searches were screened in duplicate. Two reviewers independently screened titles and abstracts to identify potentially eligible records.

The full texts of potentially relevant articles were retrieved and independently assessed for eligibility by the same two reviewers using predefined inclusion criteria. Disagreements at any stage were resolved through discussion and consensus.

Data Extraction

Data were extracted using a standardized, pilot-tested data extraction form developed *a priori* and refined after piloting on a random sample of five included reviews. One reviewer performed data extraction; a second reviewer independently verified the accuracy and completeness of all extracted data. Disagreements were resolved through discussion. Where data were missing or unclear, reviews authors were not contacted due to the overview design; missing data was reported as not available in the data extraction sheets. Outcomes for which data were reported in only one review are presented individually; where multiple reviews reported on the same outcome, findings are presented together with explicit identification of the primary studies underlying each review's findings.

Primary studies overlap was assessed for each outcome across the literature reviews included. The overlapping is disclosed narratively; no formal quantitative assessment was undertaken. If an overlapping study was identified, it was disclosed in the results section and cited accordingly. Where discrepant findings were identified across reviews reporting on the same outcome, discrepancies are described explicitly and possible explanations — including differences in inclusion criteria, primary study populations, outcome definitions, and risk of bias — are discussed.

Extracted elements included:

- *Review characteristics*: authors, year of publication, objectives, country or countries of included primary studies
- *Population characteristics*: type of HCWs, clinical setting
- *Pathogen(s) examined,* as reported in the review
- *Type of respiratory protectio*n assessed (N95 respirator specification, if reported)
- *Definitions and operationalization* of acceptability, adherence, compliance, and tolerability
- Key findings related to acceptability and each outcome domain
- Adverse events reported
- Contextual factors influencing acceptability (e.g., duration of use, pandemic or outbreak context, fit testing)
- Review methods and limitations as reported by review authors

Quality Appraisal

The methodological quality of all included systematic reviews was assessed using AMSTAR 2 (A MeaSurement Tool to Assess systematic Reviews) (15), a validated 16-item critical appraisal

instrument designed specifically for systematic reviews of healthcare interventions. AMSTAR 2 appraises domains, including the priori registration of the review protocol, the comprehensiveness of the literature search, the risk of bias assessment of included studies, and, where applicable, the appropriateness of meta-analytic methods. Each review receives an overall confidence rating of high, moderate, low, or critically low, based on the presence of critical and non-critical weaknesses (15). Two reviewers independently appraised the included reviews. Discrepancies were resolved through discussion or, where necessary, consultation with a third reviewer. Quality appraisal results are reported in a summary table and were used to contextualize the strength of evidence during synthesis but did not serve as a basis for exclusion.

The quality appraisal was limited to the literature reviews included in this report. A risk of bias assessment was not conducted on individual studies as they were not considered. The overall certainty of the evidence for each outcome was not assessed. Formal certainty of evidence appraisal using the GRADE tool, as well as the collection of data on the risk of bias of primary studies included in the literature reviews were not undertaken due to time constraints. These components are acknowledged as a limitation of the present overview and should be addressed in future updates of this synthesis.

Data Analysis and Synthesis

Findings were synthesized using a narrative synthesis approach. Quantitative pooling of data was not undertaken, given the nature of this overview. Where multiple reviews reported on the same outcome, findings were compared, and discrepancies were explicitly noted and explored.

Results are presented through:

- Summary tables describing the characteristics of included reviews
- Evidence tables reporting acceptability findings stratified by use, context, and HCWs population
- Quality assessment tables summarizing AMSTAR 2 ratings for each included review
- Level of overlap of primary studies among reviews evaluating the same outcome

Although the overview did not restrict inclusion by pathogen, the pathogen(s) examined within each review are specified in all evidence summary tables. Where patterns in acceptability emerge according to pathogen type or outbreak context (e.g., prolonged N95 respirator use during COVID-19 versus non-pandemic settings), these are explicitly described and discussed.

Interpretation focused on identifying common determinants of N95 respirator acceptability, contextual and organizational factors that influence adherence and tolerability, and gaps in the existing review-level evidence that warrant further primary research.

Results

Studies description

A total of 332 titles and abstracts were screened, identified from indexed databases, of which 69 articles were assessed at full text. In addition, 18 records identified through organizational sources were assessed at full text. Following full-text screening, 28 reviews from indexed databases and three from organizational sources were included, giving a total of 31 included reviews. At the full-text stage, 41 database records and 15 organizational records were excluded. The list of excluded studies and reasons for exclusion is provided in **Appendix 2,** and the study selection process is illustrated in the PRISMA flow diagram (**Figure 1**).

The 31 included reviews were published between 2020 and 2025, reflecting the marked acceleration of evidence syntheses on personal protective equipment (PPE) during and after the COVID-19 pandemic. Review types were heterogeneous and included systematic reviews with meta-analysis (n=7), systematic reviews without meta-analysis (n=8), rapid reviews (n=5), and scoping reviews (n=8). Additionally, the sample included one qualitative evidence synthesis, one umbrella meta-analysis, and one systematic review with an evidence map. Reviews originated from a wide range of countries including Canada, Australia, Italy, Germany, Iran, and others. The complete characteristics of all included reviews are presented in **Table 1**.

The methodological quality of included reviews, assessed using AMSTAR 2, was predominantly critically low (n=24, 77%), with six reviews rated as low quality, and one review received a high-quality rating (16). The widespread critically low ratings reflect common methodological limitations including absence of a registered protocol, incomplete literature searches, and failure to account for risk of bias in primary studies when interpreting findings. Quality appraisal results are summarized in **Table 1**.

The majority of reviews focused on healthcare workers (HCWs) in acute care and hospital settings during the COVID-19 pandemic, though several also addressed prior outbreaks including SARS-CoV-1, MERS, and influenza. Three reviews focused specifically on dental HCWs (17–19). The number of primary studies included within each review ranged from 1 to 35 studies relevant to the overview's PICO, with overall review sizes ranging from 4 to 137 primary studies.

Table 1. Characteristics of included reviews

Reviews included							
Author, Year	**Name**	**Design**	**Objective**	**Total / Relevant Studies[µ]**	**Design of the included studies**	**Outcomes**	**Quality**
Jefferson, 2023(16)	Physical interventions to interrupt or reduce the spread of respiratory viruses	Systematic review and meta-analysis	To assess the effectiveness of physical interventions to interrupt or reduce the spread of acute respiratory viruses.	78 / 4	Randomized trials	Acceptability Adverse events	High

Bakhit, 2021(20)	Downsides of face masks and possible mitigation strategies: A systematic review and meta-analysis	Systematic review and meta-analysis	To systematically identify and summarize the potential downsides of mask use and discuss strategies to mitigate them, in order to inform public mask-wearing policies.	37 /10	Randomized trials; non-randomized / quasi-experimental studies; Cross-sectional / descriptive studies	Acceptability Adverse events Other Outcomes	Low
CDC, 2023(21)	Healthcare personnel use of N95 respirators or medical/surgical masks for protection against respiratory infections: a systematic review and meta-analysis [draft].	Systematic review and meta-analysis	To assess the effectiveness of medical/surgical masks compared with N95 respirators in preventing respiratory infections among healthcare personnel.	40 / 27	Randomized trials; Cohort studies	Acceptability Adverse events Other Outcomes	Low
Farah, 2025(22)	Safety implications of mask use: a systematic review and evidence map	Systematic review and evidence map	To synthesize evidence on the acute physiological, cognitive, and psychological impacts of different types of masks and identify research gaps.	19 / 1	Systematic review and meta-analysis, Comparative individual studies	Adverse events	Low
Iannone, 2020(23)	The need of health policy perspective to protect Healthcare Workers during COVID-19 pandemic. A GRADE rapid review on the N95 respirators effectiveness	Rapid Review	To assess the efficacy of N95 respirators versus surgical masks in preventing respiratory tract infections among HCWs.	4 / 1	Randomized trials	Acceptability Adverse events	Low
Leung, 2022(24)	The contribution of respiratory and hearing protection use to psychological distress in the workplace: a scoping review	Scoping review	To compile existing evidence on this emerging issue of workplace PPE-related psychological impacts.	23 / 13	Non-randomized / quasi-experimental studies; Cohort studies; Cross-sectional / descriptive studies	Adverse events	Low
Wolf, 2022(19)	How the COVID-19 Pandemic Affects Risk Awareness in Dentists: A Scoping Review	Scoping review	To summarize dentists' risk awareness, use of preventive measures (including PPE), and management of infected patients during the COVID-19 pandemic.	39 / 4	Cross-sectional / descriptive studies	Acceptability	Low
Alberta Health Services, 2020(25)	COVID-19 Scientific Advisory Group Rapid Evidence Report. Topic: What criteria should AHS use to inform changes to COVID-19 Personal Protective Equipment (PPE) guidelines in acute and long-term care?	Rapid Review	To collate evidence to inform the PPE Task Force on whether current PPE guidelines, in respect to exposure to a probable or confirmed COVID-19 patient, should be modified.	59 / 35	Randomized trials; non-randomized / quasi-experimental studies; Cohort studies; Case-control studies; Cross-sectional / descriptive studies; Qualitative / mixed-methods studies systematic reviews	Acceptability Adverse events Other Outcomes	Critically Low

Alberta Health Services, 2021(26)	COVID-19 Scientific Advisory Group Rapid Evidence Report. Interim Update: Masking guidance for healthcare workers.	Rapid Review	To supplement a previous SAG report that examined the evidence for PPE guidance and changes in acute and long-term care.	27 / 6	Meta-analysis, systematic review; Randomized trials; Cross-sectional / descriptive studies	Adverse events Other Outcomes	Critically Low
Arikpo, 2025(27)	Health and care workers' perceptions of PPE and physical distancing for COVID-19: A qualitative evidence synthesis	Qualitative evidence synthesis	To synthesize qualitative evidence on HCW's perceptions and experiences of PPE and physical distancing and identify factors influencing their uptake and adherence in healthcare settings during COVID-19.	19 / 14	Qualitative / mixed-methods studies	Acceptability Adverse events Other Outcomes	Critically Low
Balestracci, 2023(28)	Patient safety implications of wearing a face mask for prevention in the era of COVID-19 pandemic: a systematic review and consensus recommendations	Systematic review	To assess the safety, the risks and/or the respiratory physiological impact of FMs in age ranges or disease categories	63 / 8	Randomized trials; non-randomized / quasi-experimental studies; Cross-sectional / descriptive studies	Acceptability Adverse events Other Outcomes	Critically Low
Burton, 2021(29)	Performance and impact of disposable and reusable respirators for healthcare workers during pandemic respiratory disease: a rapid evidence review	Rapid Review	To synthesize evidence concerning the range of filtering respirators suitable for patient care and guide the selection and use of different respirator types.	39 / 13	Cohort studies; Cross-sectional / descriptive studies; Qualitative / mixed-methods studies	Acceptability Adverse events Other Outcomes	Critically Low
Çakar, 2025(30)	Skin Problems in the Facial Area due to the Use of Personal Protective Equipment in Healthcare Workers: A Systematic Review	Systematic review	To determine the skin problems and related factors due to the use of PPE.	15 / 15	Cross-sectional / descriptive studies	Adverse events	Critically Low
Fakherpou, 2023(31)	A systematic review of passing fit testing of the masks and respirators used during the COVID-19 pandemic: Part 1-quantitative fit test procedures	Systematic review	To systematically review studies on respirator fitting and related factors during COVID-19.	137 / 9	Randomized trials; non-randomized / quasi-experimental studies; Cross-sectional / descriptive studies / Simulation studies	Acceptability Adverse events Other Outcomes	Critically Low
Farronato, 2020(17)	A Scoping Review of Respirator Literature and a Survey among Dental Professionals	Scoping review	To assess the perceived experience associated with N95/FFP2 respirators based on the available literature and data collected through an online survey completed by Italian dental professionals.	5 / 5	Cross-sectional / descriptive studies	Adverse events	Critically Low

Franco, 2021(32)	Personal protective equipment used by health professionals in the covid-19 pandemic: scope review	Scoping review	To map the use of PPE by healthcare professionals to combat COVID-19 in healthcare settings.	13 / 10	Review articles; meta-synthesis; meta-analysis; Cross-sectional / descriptive studies; Qualitative / mixed-methods studies	Acceptability Adverse events Other Outcomes	Critically Low
Gama, 2022(33)	Does the wearing of masks change voice and speech parameters?	Scoping review	To detect, analyze, interpret and summarize the potential effects of face masks on voice assessment parameters.	9 / 3	Cross-sectional / descriptive studies	Adverse events Other Outcomes	Critically Low
Keng, 2021(34)	Personal protective equipment-related occupational dermatoses during COVID-19 among health care workers: A worldwide systematic review	Systematic review	To identify common PPE-related dermatoses, affected body sites, and occupational contacts, and propose mitigation strategies.	16 / 10	Cross-sectional / descriptive studies	Adverse events	Critically Low
Kunstler, 2022(11)	P2/N95 respirators & surgical masks to prevent SARS-CoV-2 infection: Effectiveness & adverse effects	Systematic review and meta-analysis	To compare the likelihood of SARS-CoV-2 infection and adverse events among HCWs using respirators versus surgical masks.	21 / 9	Randomized trials; non-randomized / quasi-experimental studies; Cohort studies; Cross-sectional / descriptive studies	Adverse events Other Outcomes	Critically Low
Licina, 2020(35)	Use of powered air-purifying respirator (PAPR) by healthcare workers for preventing highly infectious viral diseases-a systematic review of evidence	Scoping review	To summarize and critically appraise the effectiveness of PAPR compared with other respirators (e.g., N95/P2) in preventing infection and contamination among HCWs exposed to highly infectious viral diseases.	10 / 2	Randomized trials; non-randomized / quasi-experimental studies; Cohort studies; Case-control studies; Cross-sectional / descriptive studies	Adverse events	Critically Low
Lu, 2023(36)	Masking strategy to protect healthcare workers from COVID-19: An umbrella meta-analysis	An umbrella meta-analysis	To assess whether evidence supports the use of respirators (e.g., N95) instead of medical masks, and whether universal respirator use should be adopted in healthcare settings.	10 / 1	Systematic review and meta-analysis	Adverse events	Critically Low
Montero-Vilchez, 2021(37)	Skin adverse events related to personal protective equipment: a systematic review and meta-analysis	Systematic review and meta-analysis	To summarize the prevalence, types, and risk factors of PPE-related cutaneous adverse events and evaluate preventive measures in HCWs and the general population.	35 / 6	Clinical trials, cohort studies, case–control studies, cross-sectional studies	Adverse events	Critically Low

Sahebi, 2022(38)	Personal protective equipment-associated headaches in health care workers during COVID-19: A systematic review and meta-analysis	Systematic review and meta-analysis	To assess the prevalence of headaches associated with PPE use among HCWs during COVID-19, including headaches before and after PPE use.	26 / 25	Cross-sectional / descriptive studies	Adverse events	Critically Low
Schoberer, 2022(39)	Rapid review and meta-analysis of the effectiveness of personal protective equipment for healthcare workers during the COVID-19 pandemic	Rapid review and meta-analysis	To assess the effectiveness of PPE in preventing COVID-19 infection and the side effects experienced by HCWs in clinical settings.	11 / 10	Cohort studies; Case-control studies; Cross-sectional / descriptive studies	Adverse events	Critically Low
Schwarz, 2024(18)	Risk of SARS-CoV-2 infection in dental healthcare workers - a systematic review and meta-analysis	Systematic review and meta-analysis	To update evidence on the risk of SARS-CoV-2 transmission to dental HCWs, with a focus on infection control practices in dental settings	29 / 3	Cohort studies; Cross-sectional / descriptive studies	Acceptability	Critically Low
Shaukat, 2020(40)	Physical and mental health impacts of COVID-19 on healthcare workers: A scoping review	Scoping review	To summarize the physical and mental health impacts of the COVID-19 pandemic on HCWs.	10 / 1	Cross-sectional / descriptive studies	Adverse events	Critically Low
Shaw, 2024(41)	Best practices for communication while wearing facemasks: A scoping review	Scoping review	To identify effective communication practices while wearing face masks.	39 / 7	Randomized trials; non-randomized / quasi-experimental studies; Cross-sectional / descriptive studies; Qualitative	Other Outcomes	Critically Low
Tezcan, 2022(42)	Protective equipment-related pressure ulcers in healthcare workers during COVID-19 pandemic: A systematic review	Systematic review and meta-analysis	To examine pressure ulcers related to the use of protective equipment among HCWs during COVID-19 and the preventive measures used to reduce them.	17 / 11	Randomized trials; Cross-sectional / descriptive studies	Adverse events	Critically Low
Yapanto, 2022(43)	Prolonged Use of Protective Masks Induced Facial Skin Injury in Primary Healthcare Workers during COVID-19 Pandemic: A Systematic Review	Systematic Review	To assess the extent of facial skin injuries caused by protective mask use among primary HCWs during COVID-19.	14 / 14	Cohort studies; Cross-sectional / descriptive studies	Adverse events	Critically Low
Yu, 2021(44)	Occupational dermatitis to facial personal protective equipment in health care workers: A systematic review	Systematic review	To identify the main causes of occupational dermatoses related to facial protective equipment.	11 / 6	Cohort studies; Case-control studies; Cross-sectional / descriptive studies	Adverse events	Critically Low

Yu, 2021B(45)	COVID-19 related pressure injuries in patients and personnel: A systematic review	Systematic review	To summarize pressure injuries associated with COVID-19 and the preventive measures and treatments used to manage them.	12 / 9	Randomized trials; Cohort studies; Case-control studies; Cross-sectional / descriptive studies	Adverse events	Critically Low

[µ]*Column five reports the total number of studies included in each review and the number of studies relevant to this overview (based on the inclusion criteria). Column six describes the design of the primary studies corresponding to the studies included in this overview.*

Main findings

Findings are presented across three domains aligned with the overview's objectives: (1) acceptability of N95 respirators among HCWs; (2) physical and psychological health outcomes; and (3) other factors related to acceptability, including communication difficulties, contextual and organizational factors.

Acceptability of N95 Respirators

Acceptability was the central outcome of interest in this review. However, none of the included reviews explicitly evaluated acceptability as a predefined or directly measured outcome, nor did they provide an explicit definition of acceptability. Instead, aspects related to acceptability were reported through a range of related dimensions, including compliance, adherence, comfort, tolerability, perception of security, usability, and recommendation, and actual use. Across all domains, a consistent picture emerged: N95 respirators were generally perceived as less acceptable than surgical masks, primarily driven by greater physical discomfort, and a systematic gap was observed between recommended and actual use.

Of the 31 reviews evaluated, 19 did not explicitly report being conducted in a pandemic context (11,16,18–24,27,29,33,35,36,38–41,44), whereas the remaining 12 reviews clearly stated that they were conducted during a pandemic (17,25,26,28,30-32,34,37,42,43,45). Among these reviews, studies conducted during COVID-19 outbreaks predominated (17,25,26,28,30-32,34,37,42,43,45), followed by those during SARS outbreaks (17,25,30,45), and MERS outbreaks (25). Only two reviews included studies were conducted during influenza outbreaks (25,28).

Only five of the reviews included that were conducted in a pandemic context reported the duration of personal protective equipment PPE use (17,28,30,37,43), with usage times ranging from 1 to 14 hours. The most frequently reported durations were either less than 4 hours or more than 4 hours.

Compliance

Compliance refers to adherence to institutional protocols for correct donning, doffing, and fit checking. Evidence on compliance with mask or respirator use was mixed across the included reviews. Three reviews reported this outcome (17,21,25), one study was of high quality, one of low quality, and the other of critically low quality, with evidence derived from a small number of primary studies and minimal overlap across reviews (limited to a single shared study). Reported compliance generally ranged from approximately 57% to 82%, depending on the type of device and implementation strategy. In two reviews, targeted or fit-tested N95 respirator use showed higher compliance (82%) compared with N95

respirator use as reported in clinical practice (as low as 57%), while surgical/medical masks showed intermediate levels of compliance (around 66%) (16,21). The CDC review (21) reported similar compliance across groups based on daily self-reports (around 65% reporting “always” wearing masks), whereas observed compliance was lower overall (33.5%–40.6%). Discomfort, skin reactions, and perceived interference with patient care were reported as factors associated with lower compliance.

Adherence

Adherence refers to the extent to which HCWs consistently wear N95 respirators as recommended during patient care and the compliance refers to adherence to institutional protocols for correct donning, doffing, and fit checking. Five reviews reported on adherence to mask or N95 respirator use (16,20,21,25,32). One was of high quality, two were of low quality, and two were of critically low quality. Overall, adherence was generally high across studies. Evidence was derived from a small number of primary studies with some overlap across reviews. A meta-analysis reported higher adherence for surgical/medical masks compared with N95/P2 respirators (OR = 1.26; 95% CI 1.08–1.46) (20). Reported adherence ranged from approximately 68% to 76% depending on device type, with higher adherence observed for medical masks (76%) compared with fit-tested N95 respirators (74%) and non–fit-tested N95 respirators (68%) (16,21). In addition, high levels of adherence were reported in some studies, with 91.2% versus 80.7% of participants reporting “always” wearing masks based on self-reports, and audited adherence reaching 98.3% versus 96.6% (21). Other reviews reported consistent adherence to mask and PPE use in healthcare settings (32). Discomfort, inconvenience in work routines, and difficulties related to PPE use were reported as factors associated with lower adherence (25,32).

Comfort

Five reviews reported on comfort associated with mask or respirator use (23,25,28,29,31) one of which was of low quality and the other four of critically low quality, with no overlap of primary studies across reviews. Overall, comfort varied across types of respiratory protective equipment and study contexts, and was frequently reported as reduced during prolonged use. Discomfort was described in relation to factors such as mask design, tightness, and components including elastic bands, and included symptoms such as pain, pressure, and increased fatigue (23,25,29). Burton et al. (2021) (29) reported that 10%–60% of users experienced effects on comfort and usability across three surveys, with aggregated findings in the same review indicating discomfort in approximately 15%–40% of users depending on respirator type. Iannone et al. (2020) (23) reported that 41.9% of HCWs using N95 respirators experienced discomfort compared with 9.8% among those using surgical masks.

Differences in comfort were observed across respirator types, with some devices (e.g., half-face respirators) reported as more comfortable than others (e.g., full-face devices) (25), and filtering facepiece respirators generally rated as more comfortable than elastomeric or powered air-purifying respirators, although PAPRs were associated with lower heat-related discomfort (29). Usability-related factors such as breathability, heat, and speech intelligibility were also reported to influence perceived comfort (31). One review reported that short breaks after 1–2 hours of continuous use may improve tolerability, particularly in specific populations (28).

Use, Usability and Misuse

Five reviews reported on aspects related to use, misuse, and usability of masks and respirators (18–20,31,32), three of the studies were of critically low quality and two were of low quality with no overlap

of primary studies across reviews. Evidence on use indicated variability across settings and populations. One review reported high levels of mask use among dental professionals during the COVID-19 pandemic, although not all participants used N95 or equivalent respirators (18).

Misuse of masks and respirators was documented in one review, including frequent touching of the mask, face, and eyes during use (20). Additional findings indicated that reuse or incorrect use of PPE may occur in contexts of limited availability or prolonged use, potentially affecting safe handling practices (32).

Usability varied across respirator types and designs and was influenced by factors such as fit, breathability, speech intelligibility, and device stability (31). Differences in fit-test performance were also reported across respirator models, with substantial variation in passing rates depending on design characteristics (31). Access, availability, and perceived quality of PPE were reported to influence patterns of use across settings (32).

Tolerability

Two reviews reported on tolerability of masks and respirators (25,29), the quality of both studies was critically low with no overlap of primary studies across reviews. Overall, respirators and PPE were generally described as tolerable by HCWs, particularly when perceived as necessary protective measures

(25). However, tolerability varied across respirator types and duration of use. Burton et al. (2021) (29) reported that tolerability of FFPs (including N95-type devices) was limited over prolonged periods, with only around 30%–40% of users able to tolerate eight hours of continuous use for some respirator types. Higher tolerability (up to 55%) was observed in certain devices, such as filtering facepiece respirators with expiratory valves. Most users were able to wear filtering facepiece respirators for several hours before requiring a break, although protocol deviations during use were also reported (29). Differences in tolerability across respirator designs suggest that device characteristics may influence sustained use.

Perception of Security

Four critically low-quality reviews reported on perceptions of protection or security associated with mask and respirator use (27,31,32), with no overlap of primary studies across reviews. Overall, perceptions of protection varied across studies and settings. Some studies reported confidence in the protective effect of PPE, while others described uncertainty or concern regarding the level of protection provided (27,32). Burton et al. (2021) (29) reported that approximately 70%-80% of HCWs expressed confidence in the protection provided by their respirator, with higher confidence among users of elastomeric respirators and lower confidence among users of FFPs. Differences across healthcare settings reflected variability in PPE availability, consistency of institutional protocols, and access to training and fit testing, rather than intrinsic differences between setting types (27,32). In contexts where these elements were limited, HCWs reported greater perceived vulnerability (31).

Recommendation versus Actual Use

Wolf et al. (2022) (19), a low-quality review, documented a striking gap between endorsement and actual use among dental professionals across 18 countries (n=12,612 oral HCWs). Aggregating data from 14 primary studies, Wolf et al. found that approximately 70.3% (SD 22.1%) of dentists considered wearing N95 respirators a good idea during the COVID-19 pandemic, while only 37.7% (SD 27.6%) actually wore them — a gap of more than 30 percentage points that directly illustrates the dissociation between positive attitudes towards N95 respirator use and actual adherence in practice. This finding is particularly striking given that the review was conducted during an active respiratory pandemic in which the rationale for N95 respirator use was widely communicated and endorsed.

Study-level data within Wolf et al. (2022) (19) reveal important heterogeneity in both recommendation rates and actual use across individual countries and regions. In terms of recommendation, rates ranged from a low of 25.3% (Martinez-Beneyto 2020, Spain) to a high of 95% (Ravi 2020, India) and 94.8% (Kanaparthi 2020, India), indicating wide variation in professional consensus about whether N95 respirators should be used. However, the critical finding is that even in studies where recommendation rates were high, actual reported use was consistently and substantially lower. Alduwayhi (2020) documented the most extreme individual-study gap: 79% of dentists recommended N95 respirator use, but only 10% reported actually using one.

A regional analysis based on a questionnaire circulated via e-mail and social media platforms to dentists, reported in Wolf et al. (2022) (19), provides the most granular breakdown of this recommendation-to-use gap by world region. Recommendation rates for N95 use respirator use were: Eastern Mediterranean 63.2%, Europe 41.6%, North America 67.8%, and Western Pacific 40.5%. Corresponding actual use rates were: Eastern Mediterranean 34.4%, Europe 8.3%, North America 16.4%, and Western Pacific 25.3%. In every region, actual use was substantially lower than recommendation — but the magnitude of the gap was largest in North America (67.8% recommend, 16.4% use; gap of 51.4 percentage points) and Europe (41.6% recommend, 8.3% use; gap of 33.3 percentage points). Only in the Western Pacific was the recommendation rate below 50%, yet even there, actual use was further halved relative to recommendation. These findings indicate that the attitude–behavior gap in N95 respirator use is a global phenomenon among dental HCWs, not confined to specific health systems or cultures, and is consistently large in magnitude regardless of the baseline recommendation level.

At the country level, Austria was the notable outlier in Wolf et al. (2022) (19), with 89.7 % of dentists reporting use of N95 respirators — making it the country with the highest N95 respirator uptake in the review. Bekes (2020) also reported actual use of 89.7% in one study, and Casillas Santana (2020) reported 70.2%, suggesting that high uptake is achievable in specific national contexts, even if uncommon across the broader evidence base. These high-use outliers are important because they demonstrate that the attitude–behavior gap is not inevitable, and that country-specific factors — potentially including regulatory requirements, professional culture, institutional infrastructure, or access to fit-tested respirators — can drive actual use substantially above the global average.

Schwarz et al. (2024) (18) corroborated the geographic variation in actual N95 respirator use among dental HCWs: only 69% of Brazilian dentists wore N95 respirators as of May 2021, and in Germany,

three-quarters of dental care workers (74.2%) wore FFP masks — though no difference in SARS-CoV-2 seroprevalence was found between FFP mask users and the general German population. Wolf et al. (2022) (19) reports on the use/misuse/usability of N95/FFP respirators, finding wide variability with notable gaps between recommended and actual use in some settings, further contextualizing Wolf's findings within the broader literature on acceptability.

Taken together, the Wolf (2022) (19) findings carry several implications for this overview. First, they confirm that the presence of a positive attitude or professional endorsement of N95 respirator use is not sufficient to ensure actual uptake. Second, the magnitude of the gap is greatest in contexts where recommendation rates are highest (North America), suggesting that even when professional consensus exists, implementation barriers override it. Third, substantial variability in actual use was observed across studies, ranging from as low as 8.3% in multi-country European data to as high as 89.7% in a country-specific study. This variability points to the role of structural, regulatory, and cultural factors in determining whether endorsed behavior is translated into practice. These findings argue strongly for interventions targeted not at changing attitudes (which are already broadly positive) but at removing implementation barriers—including device discomfort, lack of fit-testing infrastructure, institutional mandate ambiguity, and supply-side access—that prevent positive attitudes from translating into consistent N95 respirator use.

Further details on these findings are provided in **Table 2** (Summary of main findings on the acceptability of N95 respirators) and **Appendix 3**

Table 2. Summary of main findings on acceptability of N95 respirators across reviews

Acceptability			
Outcome	**Review (Quality)**	**Overlapping primary studies**	**Main Findings**
Compliance	**Jefferson, 2023 (High)** CDC, 2023 (Low) Alberta Health Services, 2020 (Critically Low)	MacIntyre. 2013	*High quality review:* ● **Compliance with mask or respirator use generally ranged from about 57% to 82% depending on the device and strategy (e.g., standard vs targeted N95 respirator use).** *Rest of reviews:* ● Evidence on compliance was mixed across reviews. ● Targeted or fit-tested N95 respirator strategies tended to show higher compliance than standard N95 respirator use in some studies. ● Observed compliance was lower than self-reported compliance, suggesting possible reporting bias. ● Discomfort, skin reactions, and perceived interference with patient care were identified as factors that may reduce compliance.

Acceptability			
Outcome	**Review (Quality)**	**Overlapping primary studies**	**Main Findings**
Adherence	**Jefferson, 2023 (High)** Bakhit, 2021 (Low) CDC, 2023 (Low) Alberta Health Services, 2020 (Critically Low) Franco, 2021 (Critically Low)	Radonovich, 2019 MacIntyre, 2011 Loeb, 2022	*High quality review:* ● **One study reported adherence between 68% and 76% depending on device type (medical mask: 76%; fit-tested N95 respirator: 74%; non–fit-tested N95 respirator: 68%).** *Rest of reviews* ● Adherence was generally high across studies, with most participants reporting consistent mask or PPE use in healthcare settings. ● In comparative studies, adherence tended to be higher for surgical/medical masks than for N95/P2 respirators (pooled OR = 1.26; 95% CI 1.08–1.46). ● One study reported very high adherence, with 91.2% medical mask vs 80.7% N95 respirator reporting "always" wearing masks, and 98.3% medical mask vs 96.6% N95 respirator audited adherence. ● Discomfort, inconvenience in work routines, and problems using masks or PPE were identified as factors that may reduce adherence.
Use / Misuse / Usability	Bakhit, 2021 (Low) Wolf, 2022 (Low) Fakherpour, 2023 (Critically Low) Franco, 2021 (Critically Low Schwarz, 2024 (Critically Low)	There is no overlap	● Mask misuse was observed, including frequent touching of the mask, face, and eyes during use; similar behavior may occur with N95 respirators, although these were less consistently reported. ● Usability varied across respirator types and designs, influenced by factors such as breathability, speech intelligibility, and fit stability (the ability of the respirator to maintain a consistent seal during movement and use). ● Fit and respirator design affected performance, with large differences in fit-test passing rates across models of respirators. ● Access, availability, and quality of PPE influenced actual use, and reuse or misuse may increase the risk of self-contamination. ● Reported use of N95/FFP respirators varied widely, with notable gaps between recommended and actual use in some settings (e.g., 70.3% recommending N95 respirator use vs 37.7% reporting actual use among dentists).
Comfort	Iannone, 2020 (Low) Burton, 2021(Critically Low) Alberta Health Services, 2020(Critically Low) Balestracci, 2023 (Critically Low) Fakherpour, 2023 (Critically Low)	There is no overlap	● Comfort varied across types of respiratory protective equipment, with some respirators (e.g., half-face FFP2/FFP3) reported as more comfortable than full-face devices. ● Overall comfort was frequently reported as reduced during prolonged PPE use, and discomfort sometimes influenced mask use or work performance. ● Perceptions of comfort were influenced by factors such as mask design and components (e.g., elastic bands). ● Some HCWs tolerated PPE discomfort as a trade-off for perceived protection against infection. ● Evidence suggests that short breaks ("air breaks") after prolonged mask use may help maintain tolerability, particularly after 1–2 hours of continuous wear.

Acceptability			
Outcome	**Review (Quality)**	**Overlapping primary studies**	**Main Findings**
Tolerability	Alberta Health Services, 2020 (Critically Low) Burton, 2021 (Critically Low)	There is no overlap	● PPE and respirators were generally tolerated by HCWs, often because they were perceived as necessary protective measures. ● Tolerability varied depending on respirator type and design, with some devices (e.g., PAPRs or respirators with expiratory valves) allowing longer wear times than others. ● Prolonged use was not always tolerated, with only about 55% of users able to tolerate eight hours of respirator use in one study. ● Most users were able to wear filtering facepiece respirators for several hours before needing a break, although some protocol violations during use were observed. ● Newer respirator designs may improve tolerability, suggesting that device design and materials influence user experience during extended wear.
Perception of security	Arikpo, 2025 (Critically Low) Burton, 2021 (Critically Low) Fakherpour, 2023 (Critically Low) Franco, 2021 (Critically Low)	There is no overlap	● Perceptions of protection varied across studies, with some HCWs expressing confidence in PPE while others reported uncertainty about the level of protection provided. ● Perceived protection differed according to respirator type, with elastomeric respirators generally generating higher confidence among users than filtering facepiece respirators (including N95 respirators). ● Training and fit testing were reported to influence perceptions of safety, potentially improving users' confidence in respirator protection. ● Perceptions of protection were influenced by the availability and perceived quality of PPE, with concerns arising when equipment was considered inadequate or not aligned with recommended standards. ● Comparisons of PPE availability across healthcare settings affected perceived risk, with workers in settings lacking higher levels of protection reporting greater feelings of vulnerability.
Recommendation	Wolf, 2022 (Low)	Not applicable	● Evidence on self-reported recommendations for N95 respirator use was reported in one review focused on dental professionals. ● Across studies of dental professionals, recommendations for N95 respirator use during the COVID-19 pandemic were generally high, although they varied across regions and within regions. ● Actual reported use was often lower than recommended use, indicating a gap between recommendations and practice. ● Aggregated findings showed that about 70% of dentists considered N95 respirator use appropriate, while only about 38% reported actually using them.
Knowledge and attitudes	Fakherpour, 2023 (Critically Low)	Not applicable	● Evidence on knowledge and attitudes toward respirator use was reported in one review. ● Training and quantitative fit testing were associated with improvements in knowledge and practical skills related to respirator use, including donning, doffing, and user seal checks. ● Evidence on attitudes toward PPE use was mixed, with some studies reporting no significant differences between groups (19 (68%) of the experimental group and 14 (50%) of the control group passed the fit

Acceptability			
Outcome	**Review (Quality)**	**Overlapping primary studies**	**Main Findings**
			test (p= 0.354) in the primary study (Yeon, 2020). ● Improvements in practical competencies were observed following training and fit-testing procedures.

In Bold font, we highlight the high-quality review (Jefferson 2023). Findings summaries in the third column separate those from the high-quality review and those findings from the rest of the reviews. When they were similar across low- and high-quality reviews, it is indicated.
Note: "Review (Quality)" reflects AMSTAR II ratings (high, low, or critically low). "Overlapping primary studies" indicates shared studies across reviews. Outcomes (e.g., compliance, adherence) and findings are reported as defined in the included reviews and may vary across studies.

Physical and Psychological Health Outcomes

Headache

Headache was one of the most frequently and consistently reported physical outcomes associated with mask and PPE use, particularly with N95 respirators, documented across eleven reviews, one of which was of high quality, two of low quality and the remaining eight of critically low quality. Only one review specifically focused on this outcome, conducting a meta-analysis of PPE-associated headaches among HCWs (38), whereas in other reviews headache was reported as part of broader assessments of physical adverse effects (11,16,17,23,25,26,28,29). There was partial overlap of primary studies across reviews, with several frequently cited studies (e.g., Ong 2020; Lim 2006; MacIntyre 2011) contributing to multiple evidence syntheses. A meta-analysis of 25 studies (n=8,697,711) found a pooled prevalence of headache after PPE use of 48.27% (95% CI 40.20-56.34; I^2=99.3%), compared with 30.47% (95% CI 20.47-40.47) before PPE use, although heterogeneity across studies was very high (38). Across individual reviews, reported headache frequencies varied widely, including 37.3% in one study of N95 respirator users, 51.6% in another sample, and 81.0% reporting de novo PPE-associated headaches in one study (17,25,28,29). Evidence from comparative studies indicated higher frequencies of headache among respirator users than among surgical or medical mask users. For example, one trial reported headaches in 13.4% of N95 respirator users compared with 3.9% of medical mask users (16), while another review reported similar differences (13% vs 4%) (20). In one of the reviews, the findings of 10 aggregative studies suggest headaches are generally more frequent among N95 users compared with

surgical mask users, with 7 studies (N=5,272) supporting this association (21). In addition, one study included in a systematic review reported higher odds of de novo headache among respirator users compared with surgical mask users (OR=2.14; 95% CI 1.07–4.32) (11). Prolonged use was repeatedly reported as a factor associated with headache occurrence, particularly when respirators or PPE were worn for more than 4 hours per day (17,25,28,29,38).

Dermatological Adverse Effects

Dermatological adverse effects were among the most frequently reported physical outcomes associated with mask and PPE use in fifteen reviews, with prolonged use and higher levels of protection. Only one of these reviews was of high quality, two of low quality, and the other 12 were of critically low quality. Evidence was reported in multiple reviews (21,23,25,28,30,34,37,42–45) representing the outcome with the greatest overlap of primary studies across reviews, with recurrent inclusion of studies such as Lan 2020, Lin 2020, Jiang 2020, and Hu 2020. Some reviews specifically focused on dermatological outcomes as their primary objective (30,34,37,43,45), while others focused more narrowly on pressure-related skin injuries as a specific subtype of dermatological outcomes (42,44). In contrast, in several broader reviews dermatological effects were reported as secondary outcomes.

Across studies, commonly reported skin conditions included device-related pressure injuries (DRPIs), irritant and allergic contact dermatitis, acne, erythema, dryness, itching, maceration, fissures, and broader skin barrier disruption, most frequently affecting the nasal bridge, cheeks, ears, forehead, and hands. Reported prevalence varied widely across studies and settings. Some reviews reported prevalence of device-related pressure injuries of around 30%, while broader skin reactions or damage were frequently reported in over 70–90% of HCWs in certain settings (25,30,34,37,42,43,45). Individual reviews also reported high estimates, including 74.5% for adverse skin reactions, 79.5% for skin damage, and up to 95–97% for skin reactions associated with N95 respirator or PPE use, although these estimates were derived from heterogeneous primary studies and varied across contexts.

Evidence across outbreak contexts further highlights this variability. In a synthesis of six studies conducted during COVID-19, Montero-Vilchez et al. (2021) (37) identified prolonged use as the main risk factor, with wearing N95 respirators or goggles for more than six hours associated with increased occurrence of skin events. Similarly, Çakar et al. (2025) (30), including studies from both SARS and COVID-19 contexts, reported prevalence estimates ranging from approximately 35% to 95%, reflecting substantial variability across settings and populations.

Reviews focusing specifically on pressure-related skin injuries reported that these lesions were most often mild (Grade I) and commonly located at PPE contact points such as the nasal bridge and cheeks (37,42,45). Across reviews, longer duration of PPE use—particularly exceeding 4-6 hours per day—was consistently identified as a key factor associated with increased risk of skin injury, along with higher levels of PPE, sweating, and combined use of respirators and eye protection (25,37,42,43,45). Comparative evidence also suggested that respirator use, including N95 or FFP2/FFP3 devices, was associated with higher rates of facial irritation, pressure injuries, and some skin symptoms than surgical masks in some studies (11,16).

Respiratory Symptoms and Physiological Effects

Respiratory symptoms were commonly reported in seven reviews, particularly among users of tight-fitting respirators such as N95/FFP2 (11,16,17,21,23,25,28). One of the reviews was of high quality,

another three of low quality, and finally three were of critically low quality. Frequently described symptoms included breathing difficulty, dyspnea, increased breathing effort, and sensations of suffocation or restricted airflow, as well as nasal symptoms such as irritation and rhinitis. Comparative evidence suggested that respirators were generally associated with greater respiratory discomfort than surgical masks, although findings were not entirely consistent across studies (11,16, 21,26). Prolonged use, particularly beyond 4–6 hours, was consistently associated with increased symptom burden (17,25). Evidence on physiological effects was more limited. Some reviews reported small changes in oxygen saturation, carbon dioxide levels, and perceived exertion during respirator use; however, these changes were generally not clinically significant (17,22,28). Overall, findings indicate that respiratory effects are more pronounced in subjective symptoms than in objective physiological impairment.

Psychological and Cognitive Effects

Psychological and cognitive effects associated with mask and respirator use were reported across several reviews (11,17,20,21,22,24,27,40), two of the reviews was of low quality; the rest were of critically low quality. Commonly described outcomes included stress, anxiety, fatigue, and feelings of isolation, particularly in contexts involving prolonged use of face-covering PPE. Evidence synthesized in Leung et al. (2022) (24) further indicated that mask use was associated with increased stress and fatigue, as well as more negative interpersonal perceptions, with some studies also suggesting perceived negative effects on decision-making and concentration.

Additional findings across reviews reported perceived cognitive impacts, including difficulties with attention, concentration, and decision-making while wearing masks or respirators (11,17,24). These effects were often described alongside physical discomfort and respiratory symptoms, suggesting a cumulative burden during extended use. Qualitative evidence also highlighted experiences of psychological discomfort such as claustrophobia, altered mood, breathlessness, and reduced situational awareness, while indicating that familiarity with PPE could facilitate adaptation over time (20,24,27). Prolonged duration of use, particularly beyond standard work shifts (e.g., >8 hours), was identified as an important factor associated with increased psychological strain. Evidence on measurable psychological outcomes was limited, although one review reported small increases in perceived psychological burden during mask use, with slightly higher levels observed for FFP2/N95 respirators compared with no mask (22). Overall, findings suggest that psychological and cognitive effects are primarily based on self-reported experiences rather than objective cognitive measures.

Discomfort

Discomfort associated with mask and respirator use was widely reported eleven reviews (16,17,20-21,23,27–29,31,32,35) of which one was of high quality, four of low quality, and six of critically low quality. Some overlap in primary studies was identified across reviews, particularly involving frequently cited studies (e.g., MacIntyre 2011; Lim 2006; Ong 2020). The prevalence of discomfort varied considerably across studies and contexts, with estimates ranging from approximately 10% to 60% of users depending on the7%pe of device and setting. Perceived discomfort was often described as multifactorial and linked to a combination of symptoms, including breathing difficulty, heat, facial pressure, headaches, and skin irritation. Qualitative and quantitative evidence consistently highlighted physical contributors such as tight mask fit, pressure on the nose and ears, increased facial temperature, humidity, and friction from straps and mask materials (17,27,31). Differences in comfort were observed across respirator types.

Some reviews suggested that FFP (e.g., N95 respirator) were perceived as more comfortable than

elastomeric respirators or powered air-purifying respirators, although findings varied depending on device characteristics and study context (31,35). Despite these challenges, respirator use was generally considered tolerable, as discomfort was often outweighed by the perceived need for protection, particularly in high-risk clinical settings (20,27).

Others physical health outcomes

Evidence from three studies (N=218) evaluated in CDC, 2023 (21) suggests dizziness is more frequent among N95 users compared with surgical mask users. Findings were reported with eight or more hours of PPE use.

Evidence from three studies (N=1,589) included in CDC, 2023 (21) overall suggests no clear difference in pain between N95 and surgical mask users.

Finally, three studies (N=51, 128, and 68) assessed heart rate changes: one (N=51) found a significant increase with N95 use after 1–3 hours, another (N=128) reported no differences between N95 and surgical masks, and one RCT (N=68) observed a slight decrease after 8 hours; Overall, cardiovascular adverse events were inconsistent and remained within normal ranges (21).

A summary of physical and psychological health outcomes associated with N95 respirator use is presented in **Table 3**, with additional details provided in **Appendix 3**

Table 3. Summary of physical and psychological health outcomes associated with N95 respirator use

Physical and psychological health outcomes			
Outcome	**Review (Quality)**	**Overlapping primary studies**	**Main Findings**
Headaches	**Jefferson, 2023 (High)** CDC, 2023 (Low) Iannone, 2020 (Low) Alberta Health Services, 2020 (Critically Low) Alberta Health Services 2021(Critically Low) Balestracci, 2023 (Critically Low) Burton, 2021 (Critically Low) Farronato, 2020 (Critically Low) Franco, 2021 (Critically Low) Kunstler, 2022 (Critically Low) Sahebi, 2022 (Critically Low)	Lim, 2006 Ong, 2020 MacIntyre, 2011	*High quality review* ● **Respirators (e.g., N95/FFP2) tended to be associated with more headaches than surgical masks in comparative studies.** *Rest of reviews:* ● Headaches were commonly reported across reviews, with substantial variability in prevalence across primary studies and settings. ● De novo headaches were frequently described among HCWs using N95/FFP2 respirators or full PPE. ● Prolonged wear time, especially >4 hours, was repeatedly identified as a risk factor for headache onset or worsening. ● The CDC, 2023 findings suggest that headaches are generally more common among N95 respirator users compared to surgical mask users. ● A meta-analysis found that headache prevalence was higher after PPE use than before PPE use (48.27% vs 30.47%),

Physical and psychological health outcomes			
Outcome	**Review (Quality)**	**Overlapping primary studies**	**Main Findings**
			although heterogeneity was very high.
Skin conditions	**Jefferson, 2023 (High)** CDC, 2023 (Low) Iannone, 2020 (Low) Balestracci, 2023 (Critically Low) Çakar, 2025 (Critically Low) Franco, 2021 (Critically Low) Keng, 2021 (Critically Low) Kunstler, 2022 (Critically Low) Lu, 2023 (Critically Low) Montero-Vilchez, 2021 (Critically Low) Shaukat, 2020 (Critically Low) Tezcan, 2022 (Critically Low) Yapanto, 2022 (Critically Low) Yu, 2021(Critically Low) Yu 2021B (Critically Low)	Lan, 2020 Hu, 2020 Abiakam, 2021 Foo, 2006 Jiang, 2020 Lin, 2020 Daye, 2020 Techasatian, 2020 Battista, 2021 Han, 2021 MacIntyre, 2011 Radonovich, 2019	*High-quality review and the rest of reviews:* ● Skin reactions were frequently reported among HCWs using masks or respirators, including pressure injuries, dermatitis, itching, erythema, and acne. ● Pressure-related injuries on the nasal bridge, cheeks, and behind the ears were commonly described, particularly with tight-fitting respirators such as N95/FFP2. ● Prolonged PPE use (especially >4–6 hours) was consistently identified as a major risk factor for skin damage. ● Some studies reported very high prevalence of skin reactions, with rates exceeding 40–70% among HCWs using PPE for extended periods. ● Moisture, friction, occlusion, and tight straps were commonly identified as contributing factors to skin irritation and injury.

Physical and psychological health outcomes			
Outcome	**Review (Quality)**	**Overlapping primary studies**	**Main Findings**
Breathing difficulties / respiratory discomfort	**Jefferson, 2023 (High)** CDC, 2023 (Low) Farah, 2024 (Low) Iannone, 2020 (Low) Balestracci, 2023 (Critically Low) Farronato, 2020 (Critically Low) Kunstler, 2022 (Critically Low)	İpek, 2021 MacIntyre, 2011	*High Quality review:* ● **Differences in difficulty breathing (from one study, MacIntyre 2011): 19.4% in N95 respirator users vs 12.5% in medical-mask users (P = 0.01)** *Rest of reviews:* ● Breathing discomfort or dyspnea was frequently reported among HCWs using respirators or full PPE, particularly with tight-fitting respirators such as N95/FFP2. ● Respirators were generally associated with greater breathing resistance or respiratory discomfort than surgical masks in comparative studies. ● Prolonged PPE use was commonly associated with increased breathing difficulty and perceived respiratory burden. ● Reported symptoms included shortness of breath, increased breathing effort, and a sensation of suffocation or reduced air flow during respirator use.
Vocal and speech effects	Gama, 2021 (Critically Low)	Not applicable	● Face masks, including N95 respirators, were associated with measurable effects on vocal production and voice parameters. ● Mask use was associated with increased vocal intensity, suggesting that speakers may raise their voice to compensate for acoustic attenuation caused by masks. Prolonged mask use was associated with signs of vocal fatigue, including changes in vocal parameters after workday.
Psychological and cognitive effects	Bakhit, 2021 (Low) CDC, 2023 (Low) Farronato, 2020 (Critically Low) Kunstler, 2022 (Critically Low) Leung, 2022 (Critically Low)	İpek, 2021	● Psychological effects associated with respirator or PPE use were reported across several studies, including stress, anxiety, fatigue, and feelings of isolation among HCWs. ● Face-covering PPE and prolonged mask use were associated with increased stress and fatigue, particularly when worn for extended periods (e.g., more than 8 hours). One of the reviews suggests that fatigue is more common among N95 mask users compared to surgical mask users with data derived from 3 aggregative studies. ● Some studies reported potential cognitive impacts, including perceived difficulties with concentration or decision-making while wearing masks or respirators. ● Qualitative evidence described anxiety, breathlessness, and psychological discomfort during prolonged N95 respirator use, although familiarity with PPE sometimes improved adaptation over time. Familiarity refers to prior use of PPE. For example, otorhinolaryngologists had hitherto used masks during tracheostomy. Some health and care workers were already familiar with PPE use, for example, some health and care workers reported using PPE found in HIV kits.

Physical and psychological health outcomes			
Outcome	**Review (Quality)**	**Overlapping primary studies**	**Main Findings**
Discomfort	**Jefferson, 2023 (High)** CDC, 2023 (Low) Bakhit, 2021 (Low) Iannone, 2020 (Low) Licina, 2020 (Low) Arikpo, 2025 (Critically Low) Balestracci, 2023 (Critically Low) Burton, 2021 (Critically Low) Fakherpour, 2023 (Critically Low) Farronato, 2020 (Critically Low) Franco, 2021 (Critically Low)	MacIntyre, 2011 MacIntyre, 2013 Lim, 2006 Ong, 2020	*High-quality review*: ● **Differences in discomfort between masks (One study: MacIntyre 2011): 41.9% in N95 respirator users vs 9.8% in medical-mask users (P < 0.01)** *Rest of reviews:* ● General discomfort associated with respirator or PPE use was commonly reported among HCWs. ● Perceived comfort varied according to respirator type. In one study, filtering facepiece respirators (e.g., N95 respirators) were rated as more comfortable than elastomeric half-face respirators and powered air-purifying respirators. ● In some studies, a notable proportion of users reported comfort or usability (defined as subjective discomfort, wear efficiency, and speech intelligibility) issues, with reported discomfort ranging from approximately 10% to 60% depending on respirator type and study context. ● Reported discomfort was often related to specific symptoms, including breathing difficulty, heat, facial pressure, headaches, or skin irritation. ● Despite discomfort, respirator use was generally tolerated because it was perceived as necessary for protection. In one of the reviews evaluated, two studies reported greater discomfort with N95 respirators compared to medical masks, and one study reported greater discomfort with medical masks compared to N95 respirators.
Others physical health outcomes	CDC, 2023 (Low)	Not applicable	● Evidence from three studies (N=218) suggests dizziness is more frequent among N95 users compared with surgical mask users. Findings were reported with eight or more hours of PPE use. ● Evidence from three studies (N=1,589) overall suggests no clear difference in pain between N95 and surgical mask users. ● Three studies (N=51, 128, and 68) assessed heart rate changes: one (N=51) found a significant increase with N95 use after 1–3 hours, another (N=128) reported no differences between N95 and surgical masks, and one RCT (N=68) observed a slight decrease after 8 hours; overall, cardiovascular adverse events were inconsistent and remained within normal ranges.

In Bold font, we highlight the high-quality review (Jefferson 2023). Findings summaries in the third column separate those from the high-quality review and those findings from the rest of the reviews. When they were similar across low- and high-quality reviews, it is indicated.
Note: "Review (Quality)" reflects AMSTAR II ratings (high, low, or critically low). Only primary studies included in two or more reviews (i.e., overlapping studies) are presented. Primary studies included in a single review are not shown. The number of reviews in which each study appears is detailed in the citation matrix (Appendix 4). A formal quantitative measure of overlap was not conducted. . Outcomes and findings are reported as defined in the included reviews and may vary across studies.

Other Factors Influencing Acceptability

Communication Difficulties

Communication difficulties associated with masks, respirators, and PPE use were reported across eleven reviews (20,21,24–29,32,33,41). Nine of these reviews were rated as having critically low quality and two as low quality. One review specifically focused on communication as its primary outcome, examining factors and strategies affecting communication while wearing masks (41), whereas in other reviews this outcome was reported as part of broader acceptability or usability domains. Some overlap in primary studies was identified across reviews, particularly involving frequently cited experimental and survey-based studies.

Across reviews, PPE was described as interfering with verbal communication, including reduced speech intelligibility, impaired hearing, and difficulties in understanding spoken information. Experimental evidence reported reductions in speech discrimination and sentence comprehension when PPE was worn, particularly in simulated clinical environments. Survey-based findings indicated that approximately 20%–30% of HCWs reported that respirator use interfered with communication, while qualitative evidence described challenges in routine clinical interactions (27,29). Communication difficulties also included reduced ability to perceive facial expressions and emotional cues, affecting interactions between HCWs and patients (27,41). The extent of communication impairment varied according to device type and context. Greater impairment was reported with elastomeric respirators and powered air-purifying respirators compared with N95 respirators or surgical masks. One review reported that filtering facepiece respirators had a Speech Intelligibility Index (SII) of 0.7 (normal = 1), while elastomeric respirators showed lower intelligibility (SII 0.44–0.48) (29). Additional layers of protection were associated with further reductions in speech clarity (29,41). Communication difficulties were also reported to be more pronounced in noisy environments and in pediatric settings. Gama et al. (2021) (33) additionally reported increased perceived vocal effort and changes in voice parameters during mask use.

Institutional Policy and Supply-Level Factors

Institutional policy and supply-related factors influencing respirator and PPE use were reported in two reviews (27,32), all studies both were of critically low quality. No overlap in primary studies was identified across these reviews. Institutional policies and guidelines were described as influencing PPE use, with variability in recommendations and protocols reported across and within countries (32).

Institutional guidance, including updated guidelines and role modelling by senior staff, was reported as to facilitate PPE use (27). Organizational and environmental factors, such as the layout of healthcare facilities and the designation of clean and contaminated areas, were also described as influencing PPE implementation. Infrastructure for donning and doffing PPE, including the availability of changing areas, was reported to affect PPE use (27). PPE supply and availability were reported to influence its use among HCWs. Access to PPE was frequently described, although its adequacy and quality were reported as insufficient in some cases. Two primary studies in Franco 2021 (32) conducted among doctors and other professionals—such as nurses, social workers, pharmacists, and hospital administrative staff—reported that most participants had access to PPE; however, few considered it adequate or of good quality. In addition, the same review (32) reported that many healthcare professionals did not have the equipment recommended by the WHO guidance. Variability and inequities in the availability and provision of PPE across settings, including differences in the types and combinations of equipment used, was also reported (27,32). Inequities in access to PPE across

healthcare settings were described (27).

Training and Fit Testing

Training and fit testing related to respirator use were reported in one review (31) of critically low-quality. Training interventions, including online training combined with quantitative fit testing, were reported to improve HCWs' knowledge and practical competencies, including donning and doffing procedures and user seal checks (31).

Cultural, Behavioral, and System-Level Contextual Factors

Cultural, behavioral, and system-level contextual factors influencing PPE use were reported in two reviews (27,29), both reviews were of critically low quality. No overlap in primary studies was identified. System-level factors included reported gaps between PPE guidelines and their implementation in practice, with studies describing situations in which recommended protocols were difficult to follow under routine conditions (27). In some settings, HCWs reported adapting PPE practices based on local constraints and conditions. Cultural and behavioral factors were described as influencing how PPE was understood and adopted, including perceptions of usability and protection. Participants described trade-offs between ease of use and perceived protection, including perceived impacts on patient care, as well as variation across contexts. PPE was also described in some settings as a temporary protective measure rather than a long-term practice (29). Individual-level factors were also reported to influence PPE use. HCWs described challenges in balancing PPE use with clinical demands, including situations in which urgent patient care limited the ability to follow recommended procedures (27).

Organizational / System-Level Contextual Factors

Organizational and system-level contextual factors influencing PPE use were reported in one critically low-quality review (27). Across included studies, gaps between PPE guidelines and their implementation in practice were described. Situations were reported in which recommended protocols were difficult to follow under routine conditions, leading HCWs to adapt practices based on local constraints and resource availability. In some cases, protocols requiring strict PPE use, such as discarding respirators after each use, were reported as not feasible in practice, and adaptations to these recommendations were described. A summary of the main findings on other aspects related to N95 respirator use is presented in **Table 4** (Summary of main findings on other aspects related to N95 respirator use), with additional information available in **Appendix 3**.

Table 4. Summary of main findings on other acceptability-related outcomes of N95 respirators

Other Acceptability-Related Outcomes			
Outcome	**Review (Quality)**	**Overlapping primary studies**	**● Main Findings**
Communication difficulties	Bakhit, 2021 (Low) CDC, 2023 (Low) Alberta Health Services, 2020 (Critically Low) Alberta Health Services 2021(Critically Low) Arikpo, 2025 (Critically Low) Balestracci, 2023 (Critically Low) Burton, 2021(Critically Low) Franco, 2021 (Critically Low) Gama, 2021 (Critically Low) Leung, 2022 (Critically Low) Shaw, 2024(Critically Low)	Bandaru, 2020 Hayirli, 2021 MacIntyre, 2011 Radonovich, 2009 Schlögl, 2021	● PPE and respirators were consistently reported to interfere with communication between HCWs and patients, including difficulties with speech intelligibility, hearing, and understanding spoken information. ● Speech intelligibility decreased when PPE was worn, with experimental studies showing reductions in speech discrimination scores and sentence comprehension. ● Respirator type influenced communication performance, with greater impairment reported for elastomeric respirators and PAPRs compared with N95 respirators or surgical masks. ● Subjective communication difficulties were commonly reported, with surveys indicating that approximately 20–30% of users experienced communication interference when wearing respirators. ● PPE also affected interpersonal interactions and patient–provider relationships, as masks obscured facial expressions and emotions, potentially reducing rapport and understanding. ● Communication barriers were more pronounced in noisy environments (e.g., operating rooms) and when additional layers of respiratory protection were used.
Institutional Policy / Mandate on Respiratory Protective Equipment (RPE)	Arikpo, 2025 (Critically Low) Franco, 2021 (Critically Low)	There is no overlap	● Institutional policies and guidelines influenced PPE use and adherence, with variability in recommendations and protocols reported across and within countries. ● Clear institutional guidance and leadership support facilitated PPE use, including updated guidelines and role modelling by senior staff. ● Organizational and environmental factors within healthcare facilities affected PPE implementation, such as the layout of clinical areas and the designation of clean and contaminated zones. ● Inadequate infrastructure for donning and doffing PPE (e.g., lack of private changing areas) created practical barriers and discomfort for HCWs.

Respiratory Protective Equipment (RPE)RPE Supply / Availability	Arikpo, 2025 (Critically Low) Franco, 2021 (Critically Low)	There is no overlap	● Availability of PPE influenced its use among HCWs, with supply levels affecting the ability to follow recommended protective practices. ● Access to PPE was frequently reported, but its adequacy and quality were often considered insufficient, particularly in relation to recommended standards. ● Variability in the availability and provision of PPE was reported across settings, including differences in the types and combinations of equipment used. ● Inequities in access to PPE were described, with some healthcare settings having adequate equipment while others faced limited resources, generating concerns about unequal protection and safety. ● Two studies conducted interviews with nurses from different healthcare settings (hospital, field hospital, home emergency services, primary care, and nursing homes), as well as with doctors, nurses, medical associate professionals, pharmacists, and other staff. However, they did not report in detail who received PPE and who did not, nor did they provide information on outcomes related to respirator availability.
Training / Education	Fakherpour, 2023(Critically Low) Burton, 2021(Critically Low)	Not applicable	● Training and fit testing improved knowledge and practical competencies related to respirator use, including donning, doffing, and user seal checks. ● Failure to follow guidelines for safe use is common both in donning / doffing and during use. Repeated training appears to be necessary to ensure continuing safe respirator fit.
Organizational / System-Level Contextual Factors	Arikpo, 2025 (Critically Low)	Not applicable	● Across studies, a gap between PPE guidelines and their implementation in practice was reported. In some settings, strict protocols (e.g., discarding respirators after each use) were difficult to follow due to resource constraints, leading HCWs to adapt practices based on availability and local conditions.
Cultural / Behavioral Contextual Factors	Burton, 2021(Critically Low)	Not applicable	● PPE use was influenced by personal, social, and cultural factors, shaping how HCWs understood and adopted protective practices. Some participants described trade-offs between usability (including impacts on patient care) and protection, and in some contexts, PPE was perceived as a temporary protective measure rather than a sustainable long-term practice.

Other Contextual Factors	Arikpo, 2025 (Critically Low)	Not applicable	● Individual factors among HCWs influenced PPE use. Clinicians described dilemmas between prioritizing urgent patient care and taking time to don PPE, particularly in emergency situations. PPE was also reported to make clinical tasks more physically demanding, contributing to fatigue, discomfort, and perceived reductions in work performance.

Findings summaries in the third column separate those from the high-quality review and those findings from the rest of the reviews. When they were similar across low- and high-quality reviews, it is indicated. Note: "Review (Quality)" reflects AMSTAR II ratings (high, low, or critically low). "Overlapping primary studies" lists selected examples of shared studies across reviews and is neither exhaustive nor indicative of the frequency of overlap. Outcomes reflect contextual, organizational, and system-level factors influencing respirator use and may vary across studies.

Methodological issues and quality of evidence of included studies

The methodological quality of all 31 included systematic reviews was assessed using AMSTAR 2, a validated 16-item tool comprising seven critical domains: prior registration wards the review protocol (Q2); use of a comprehensive literature search strategy (Q4); provision of a list of excluded studies with justification (Q7); risk of bias assessment of individual studies (Q9); appropriate methods for statistical combination towards-analysis was performed (Q11); consideration of risk of bias in the interpretation of results (Q13); and investigation of publication bias (Q15). A weakness in any critical domain results in a confidence rating no higher than Critically Low.

As shown in **Figure 2** and **Table 2**, the majority of included reviews received a critically low confidence rating (n=24; 77%). Six reviews were rated as low (19–23,35), and one review (16) received a high confidence rating. The most repeated weakness across reviews was the absence of a pre-registered protocol (Q2), which was absent in 22 of 31 reviews.

Comprehensive search strategies (Q4) were frequently rated as partial yes, reflecting limitations such as restriction to few databases or omission of grey literature. Risk of bias assessment of included primary studies (Q9) was not performed or inadequately performed in the majority of reviews, and failure to account for risk of bias in the interpretation of findings (Q13) was similarly common. These limitations primarily reflect methodological shortcomings in the conduct and reporting of the reviews themselves, rather than the design of the underlying primary studies. These weaknesses must be considered when interpreting the evidence synthesized in this overview.

Importantly, the overall confidence in the evidence is also influenced by the design of the primary studies contributing to each outcome (**Table 1**). Most findings on acceptability, adverse events, and related outcomes were derived predominantly from cross-sectional, descriptive, and qualitative studies, with fewer randomized or controlled designs. This was particularly evident for outcomes such as dermatological effects, discomfort, and behavioral measures (e.g., compliance or adherence), which were largely informed by observational or self-reported data.

While these study designs are appropriate for capturing experiential and implementation-related outcomes, they inherently limit causal inference and may introduce reporting biases. As a result,

findings from this overview should be interpreted with caution, particularly where evidence is derived from non-comparative or self-reported data.

Figure 2. AMSTAR 2 quality scores of included studies

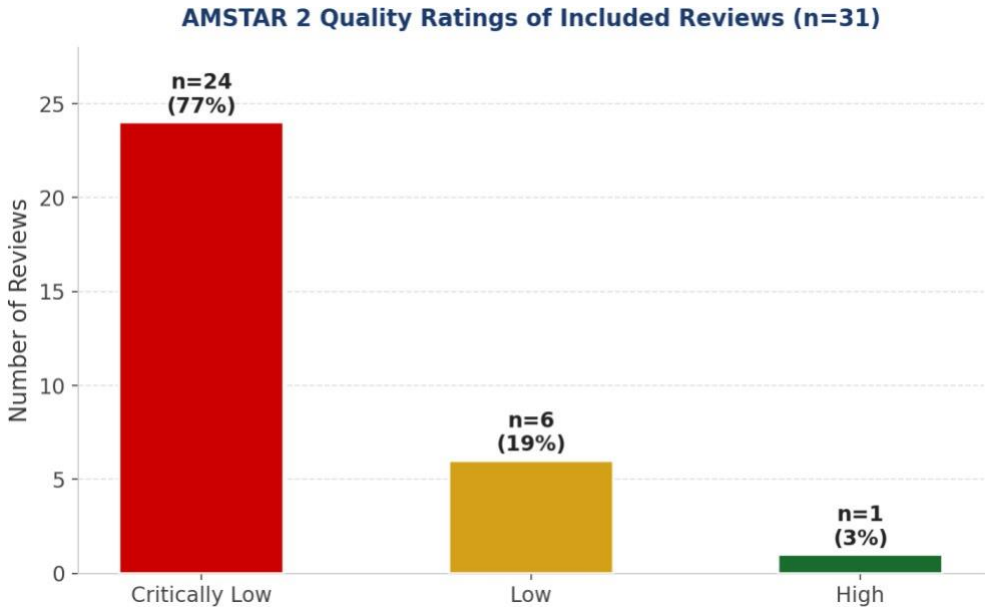


Table 5. AMSTAR 2 item-level appraisal of included systematic reviews.

Review	Q1	Q2*	Q3	Q4*	Q5	Q6	Q7*	Q8	Q9.1*	Q9.2*	Q10	Q11*	Q12*	Q13*	Q14	Q15*	Q16	Overall Rating
Alberta Health Services, 2020	Y	N	Y	PY	N	N	N	Y	N	N	N	NMA	NMA	Y	Y	NMA	N	Critically Low
Alberta Health Services, 2021	Y	N	Y	PY	N	N	N	Y	N	N	N	NMA	NMA	Y	Y	NMA	N	Critically Low
Arikpo, 2025	Y	Y	Y	N	Y	Y	N	PY	NA	NA	N	NMA	NMA	NA	NA	NMA	Y	Critically Low
Bakhit, 2021	Y	Y	Y	PY	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Low
Balestracci, 2023	Y	N	N	PY	Y	N	N	PY	N	N	N	NMA	NMA	N	Y	NMA	Y	Critically Low
Burton, 2021	Y	Y	N	PY	N	N	N	N	N	N	N	NMA	NMA	N	N	N	Y	Critically Low
CDC, 2023	Y	N	Y	PY	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Low
Çakar, 2025	Y	N	Y	PY	Y	Y	N	PY	NA	Y	N	NMA	NMA	Y	N	NMA	Y	Critically Low
Fakherpour, 2023	Y	N	N	PY	Y	N	Y	PY	N	PY	N	NMA	NMA	Y	N	NMA	Y	Critically Low
Farah, 2025	Y	Y	Y	PY	Y	Y	N	PY	Y	PY	N	NMA	NMA	Y	Y	NMA	Y	Low
Farronato, 2020	Y	N	N	PY	Y	Y	N	Y	NA	NA	N	NA	NA	NA	NA	NA	Y	Critically Low
Franco, 2021	Y	N	N	PY	Y	N	N	PY	NA	NA	N	NA	NA	NA	NA	NA	Y	Critically Low
Gama, 2022	N	N	N	PY	N	N	N	PY	NA	NA	N	NA	NA	NA	NA	NA	Y	Critically Low
Iannone, 2020	Y	N	N	PY	Y	Y	Y	Y	Y	NA	N	Y	N	Y	Y	Y	Y	Low
Jefferson, 2023	Y	Y	Y	PY	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	High
Keng, 2021	Y	Y	N	PY	Y	Y	N	PY	NA	N	N	NMA	NMA	N	N	NMA	Y	Critically Low
Kunstler, 2022	Y	PY	N	PY	Y	Y	N	PY	Y	Y	N	N	N	Y	Y	N	Y	Critically Low
Leung, 2022	N	N	N	PY	Y	N	N	PY	NA	NA	N	NA	NA	NA	NA	NA	Y	Critically Low
Licina, 2020	Y	Y	Y	PY	Y	N	N	PY	Y	Y	N	NMA	NMA	Y	Y	NMA	Y	Low
Lu, 2023	Y	N	Y	PY	Y	Y	N	PY	Y	N	N	Y	N	Y	Y	N	Y	Critically Low
Montero-Vilchez, 2021	Y	N	N	PY	Y	N	N	PY	N	N	N	Y	N	N	N	N	Y	Critically Low
Sahebi, 2022	Y	Y	Y	PY	Y	Y	N	PY	NA	N	N	N	N	N	Y	Y	Y	Critically Low
Schoberer, 2022	Y	PY	Y	PY	Y	N	Y	PY	NA	PY	N	N	N	Y	N	N	Y	Critically Low
Schwarz, 2024	N	N	Y	PY	Y	Y	N	Y	NA	Y	N	Y	N	Y	Y	N	Y	Critically Low
Shaukat, 2020	Y	N	N	PY	Y	N	N	PY	NA	NA	N	NA	NA	NA	NA	NA	Y	Critically Low
Shaw, 2024	Y	N	Y	PY	Y	Y	N	PY	NA	NA	N	NA	NA	NA	NA	NA	Y	Critically Low
Tezcan, 2022	Y	N	Y	PY	Y	N	PY	PY	NA	N	N	NMA	NMA	N	N	NMA	Y	Critically Low
Wolf, 2022	Y	N	N	PY	Y	N	PY	PY	NA	NA	N	NA	NA	NA	NA	NA	Y	Low

Review	Q1	Q2*	Q3	Q4*	Q5	Q6	Q7*	Q8	Q9.1*	Q9.2*	Q10	Q11*	Q12*	Q13*	Q14	Q15*	Q16	Overall Rating
Yapanto, 2022	Y	N	N	PY	Y	Y	N	PY	NA	PY	N	NMA	NMA	Y	N	NMA	Y	Critically Low
Yu, 2021	Y	N	N	N	N	N	N	N	NA	N	N	NMA	NMA	N	N	N	Y	Critically Low
Yu, 2021B	Y	N	N	PY	N	Y	N	N	NA	PY	N	NMA	NMA	N	N	NMA	Y	Critically Low

Item key (* = critical domain):

- Q1: Research questions and inclusion criteria include PICO components; Q2*: Review protocol established and registered prior to conduct [CRITICAL]; Q3: Justification provided for the selection of study designs; Q4*: Comprehensive literature search strategy employed [CRITICAL]; Q5: Study selection performed in duplicate; Q6: Data extraction performed in duplicate; Q7*: List of excluded studies provided with justification [CRITICAL]; Q8: Included studies described in adequate detail; Q9*: Satisfactory technique used to assess risk of bias in individual studies [CRITICAL]; Q9.1: RoB domains assessed for randomized controlled trials (RCTs); Q9.2: RoB domains assessed for non-randomized studies of interventions (NRSI); Q10: Sources of funding of primary studies reported; Q11*: Appropriate methods used for statistical combination in meta-analysis [CRITICAL]; Q12*: Potential impact of RoB assessed in the meta-analysis [CRITICAL]; Q13*: Risk of bias accounted for when interpreting/discussing results [CRITICAL]; Q14: Heterogeneity observed in results explained and discussed; Q15*: Publication bias investigated and its potential impact discussed [CRITICAL]; Q16: Potential sources of conflict of interest reported
- Y = Yes | PY = Partial Yes | N = No | NMA = No meta-analysis conducted | NA = Not applicable (e.g., scoping reviews or when the corresponding study design was not included in Q9.1 or Q9.2).

Overlap of primary studies across included reviews

A citation matrix was constructed to examine the overlap of primary studies across the included reviews. The matrix identified 300 primary study occurrences across the 31 reviews, corresponding to 261 unique primary studies, indicating a relatively low level of overlap. Most primary studies were included in only one review, while a smaller number appeared in two or three reviews, and only a few were shared by four or five reviews. The most frequently recurring studies included Hu (2020), İpek (2021), Lim (2006), and Ong (2020), each appearing in up to five reviews. Overall, this distribution suggests that although some widely cited primary studies contribute to multiple reviews, the majority of evidence is not heavily duplicated across reviews, reducing the likelihood that conclusions are disproportionately driven by the same underlying studies. In addition, among primary studies that appeared across multiple reviews, no discrepancies were identified in the reporting of findings relevant to this overview, suggesting a consistent interpretation of these data across reviews. (See overlap matrix in **Appendix 4**).

Discussion

This overview of reviews synthesized evidence from 31 systematic reviews examining the acceptability of N95 respirators among HCWs, together with the physical and psychological health effects. Overall, the available evidence suggests that N95 respirator acceptability is generally lower than that of surgical masks. Importantly, this gap appears not to be primarily driven by attitudinal resistance—HCWs consistently recognize the protective value of N95 respirators—but rather by device-related and contextual factors that may limit sustained use in practice. Across multiple dimensions related to acceptability, including adherence, comfort, tolerability, and the translation of endorsement into actual use, N95 respirators tended to perform less favorably, highlighting a persistent gap between recommendation and real-world use (16,19,20).

The available evidence on compliance largely reflects observed behavior, but does not consistently distinguish between knowledge, intention, and sustained practice. Reported factors such as discomfort and interference with clinical tasks suggest that barriers arise primarily in the transition from intention to continued use. This distinction is important when interpreting compliance findings across reviews, as it indicates that acceptability is shaped not only by perceptions but also by the feasibility of maintaining use under routine working conditions.

The evidence consistently identifies physical discomfort as the primary proximate mechanism underlying poor acceptability. Headache affected nearly half of all N95 respirator users in one pooled analysis (48.3%; 95% CI 40.2–56.3%)(46), discomfort was reported in 15–60% of users across studies, and dermatological adverse effects — particularly pressure injuries at the nasal bridge, contact dermatitis, and skin barrier disruption — were documented in up to 97% of frontline HCWs in some COVID-19-era cohorts (37). These are not incidental inconveniences: the evidence demonstrates that discomfort directly reduces compliance, is associated with improper doffing, and in dental settings creates a >30-percentage-point gap between professional endorsement and actual use (19,31).

Psychological and cognitive effects of N95 respirator use, though less extensively studied, represent a clinically important and underweighted dimension of acceptability. Prolonged respirator wear was associated with increased stress, particularly beyond eight hours (24), as well as impaired concentration and decision-making (24). Communication difficulties — affecting 20–30% of users in

surveys and measurably reducing speech intelligibility — have implications for patient safety, therapeutic relationships, and team coordination, with effects most pronounced in surgical and pediatric settings (41,47). The qualitative literature highlights that HCWs consciously suppress these burdens as a trade-off for perceived protection (27), a coping pattern that may mask the true prevalence of acceptability-related distress in quantitative studies.

The attitude–behavior gap documented by Wolf et al. (2022) (19) among dental HCWs warrants specific attention. Across 18 countries, 70.3% of dentists endorsed N95 respirator use yet only 37.7% reported wearing one. Regional analysis revealed that North America had the largest absolute gap (67.8% endorse, 16.4% use), with Europe reporting the lowest actual use (8.3%) despite a 41.6% endorsement rate. These data directly illustrate that positive attitudes towards N95 respirator use are necessary but insufficient for uptake, and that structural barriers — including device discomfort, absence of fit-testing infrastructure, inconsistent institutional mandates, and supply constraints — override professional intent. This finding aligns with behavior change theory, which distinguishes between intention and implementation (48), and suggests that acceptability interventions must target the implementation context, not merely professional attitudes.

We aimed to assess whether differences in outcomes existed between reviews conducted in pandemic contexts—such as during the COVID-19, SARS, and MERS outbreaks—and those conducted in non-pandemic settings. In pandemic situations, policies for healthcare personnel often require the prolonged use of N95 respirators. In contrast, in non-pandemic settings, their use is generally limited to situations involving patients who require specific precautions, which could result in shorter periods of use. However, no significant differences were identified between these groups of reviews. In both contexts, similar patterns of use were reported, with generally prolonged durations, and short-term use was not described.

Lastly, unfortunately, all the reviews, except for one high quality review (Jefferson 2023), were assessed as of low or critically low quality. Although many of the findings from this Jefferson (2023) review were also highlighted in low-quality reviews, it is worth highlighting the former review findings in comparison to the others. In brief, the findings of the only high-quality review are that compliance and adherence are relatively high (50-80%), and that headaches, respiratory difficulty, and discomfort are significantly more common with respirators than with surgical masks.

Strengths

This review's strengths are several. Firstly, it followed a pre-registered protocol and adhered to the Cochrane Handbook guidance for overviews and the PRIOR reporting statement, ensuring transparency and reproducibility of methods. Secondly, an extensive electronic database search was conducted, and gray literature was also evaluated across national and international public health agency websites and systematic review registries. Additionally, multiple facets of acceptability were considered, such as measures of comfort, discomfort, and user preference, as well as psychological and cognitive outcomes. Adherence, compliance, and tolerability of the N95 respirators were also taken into account. Focusing on acceptability as the primary outcome, responds to an evidence gap highly relevant to occupational health policy and clinical practice.

As a strength of this review, the inclusion of eligible publications from January 1, 2015, to the date of the search execution (02/06/2026) allows for the capture of contemporary evidence relevant to current healthcare practice and infection prevention contexts. The reviews that met the inclusion criteria were

published between 2020 and 2025.

Limitations

Several limitations should be considered when interpreting these findings. First, most included reviews were rated as low or critically low quality according to AMSTAR II. Of the 31 reviews, only one was rated as high quality, six as low, and the majority as critically low according to AMSTAR 2, which limits confidence in the robustness of the synthesized evidence. With the caveat that AMSTAR 2 appraises domains including the a *priori* registration of the review protocol which automatically places reviews in the lower category if the protocol is not registered.

Second, the underlying evidence base is largely derived from observational, cross-sectional, and descriptive studies, frequently relying on self-reported outcomes. This limits causal inference and introduces the potential for reporting bias, particularly for subjective outcomes such as discomfort, adherence, and psychological effects.

Third, a substantial proportion of the included evidence was generated in the context of the COVID-19 pandemic. This context is likely to have influenced both behaviors and reported outcomes, including the need for prolonged use of personal protective equipment PPE, heightened psychological stress, and altered working conditions. In addition, documented shortages and variability in PPE availability during the pandemic may have acted as structural constraints on use, potentially influencing observed patterns of adherence and acceptability.

Fourth, a formal quantitative assessment of overlap between primary studies across included reviews was not conducted, and overlap was therefore assessed narratively. As a result, the degree to which findings are influenced by shared primary studies remains uncertain.

Fifth, detailed risk of bias assessments at the primary study level were not extracted. Consequently, conclusions are based on review-level quality and reported study designs rather than a synthesis of primary study-level risk of bias.

Sixth, the inclusion of publications in English and French only may have excluded relevant evidence from settings where barriers to N95 respirator use may differ, particularly in low- and middle-income contexts. Finally, variability in how outcomes such as acceptability, adherence, and compliance were defined and measured across reviews may limit comparability and contribute to heterogeneity in the interpretation of findings.

Implications for Practice and Policy

The findings of this overview suggest several potential implications for occupational health policy and clinical practice in healthcare settings. Given that the majority of included reviews were rated as critically low quality on AMSTAR 2, the following considerations should be interpreted cautiously and in conjunction with the limitations described above. They are offered as evidence-informed directions for policy attention rather than definitive clinical recommendations.

First, shift design and rest break policies may benefit from considering the duration threshold emerging from this evidence base: rest breaks at or before the four-hour mark may help to mitigate headache and respiratory symptom onset, and N95 respirator use periods that ideally do not exceed six hours

without a break to reduce dermatological injury risk (37,46). While the consistency of these thresholds across reviews is notable, the predominantly observational nature of the underlying evidence means that causal conclusions should be drawn with caution. These findings nonetheless suggest that duration of uninterrupted use is a modifiable factor worth addressing in occupational health guidance, particularly in settings requiring sustained N95 respirator use.

Second, respirator fit testing and repeated practical training in donning, doffing, and user seal checking may represent valuable institutional investments. Available evidence suggests that fit testing is associated with improved safety perceptions and practical competency (31), and that failures in safe use protocols appear common without repeated reinforcement (47). Whether these represent standard requirements or enhanced practices will depend on institutional context and resources.

Third, the finding that device may be a modifiable determinant of acceptability — with newer FFR designs, nanofiber materials, and three-panel flat-fold models associated with better usability, comfort, and fit-test passage rates in some studies — suggests that procurement considerations could include user-centered acceptability criteria alongside filtration performance standards (31). Transparent N95 respirator models have shown promising results for communication and patient-provider rapport in limited studies (41). Though broader evidence is needed before strong recommendations can be made.

Fourth, the recommendation-to-use gap documented in dental settings — and the suggestion that this gap may be structural rather than attitudinal — points to potential need for targeted implementation initiatives, which could include accessible fit-testing services, clearer institutional guidance, and attention to PPE supply guarantees. It should be noted that comparable data were not systematically reported for HCWs in other clinical settings in the evaluated reviews, representing a knowledge gap that warrants attention in future research. On the other hand, the geographic variation in dental N95 respirator use (from 8.3% in Europe to 89.7% in specific study populations) nonetheless suggests that higher uptake is achievable in some contexts and should be treated as a policy target (19).

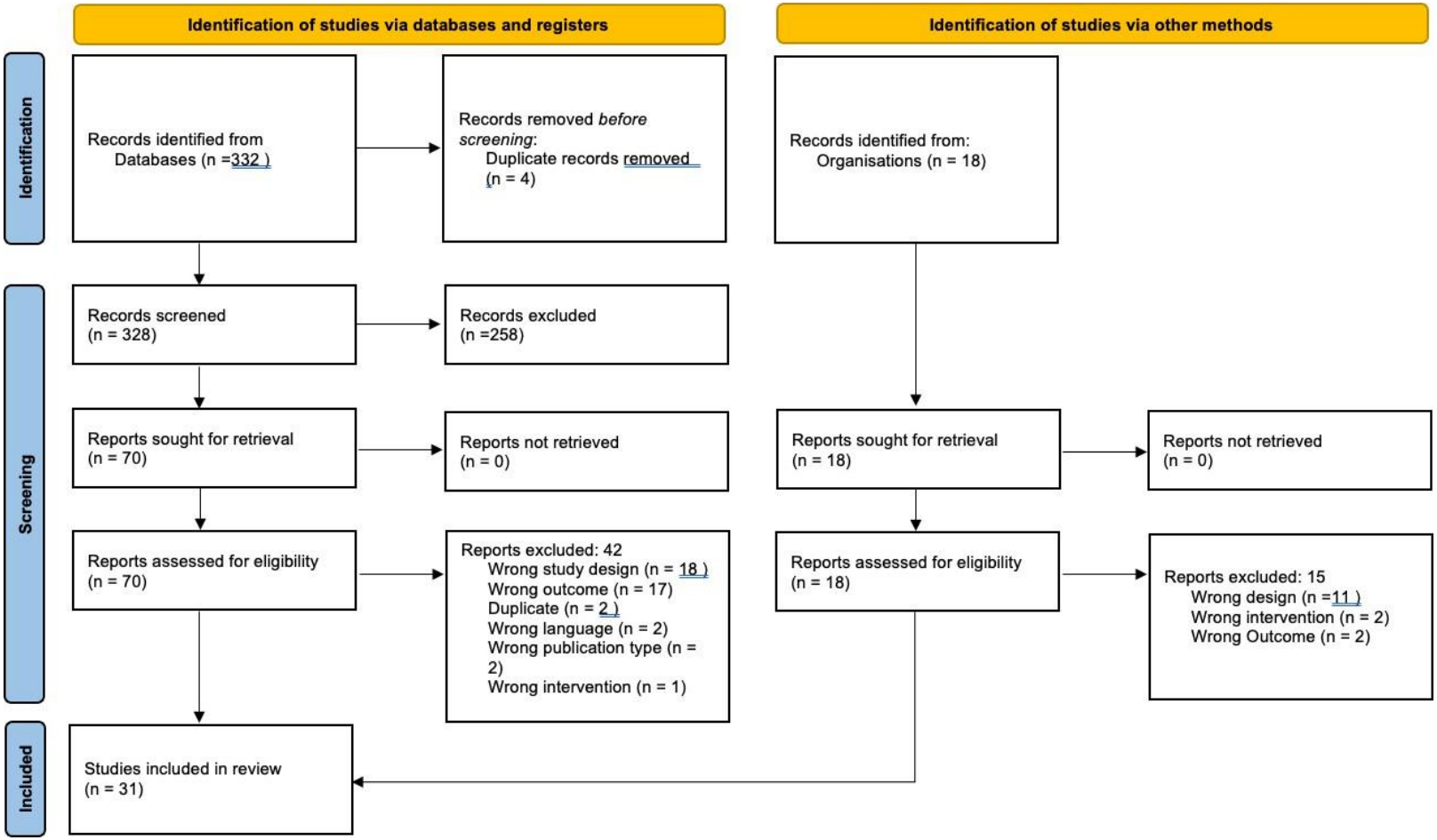
Fifth, inequities in PPE access across institutions, professional roles, and geographic settings emerged as a recurring theme in the qualitative evidence and may themselves influence acceptability: workers in less-protected settings reported heightened vulnerability and reduced motivation to comply with available — but perceived as inadequate — protection (27). These findings suggest that attention to equitable PPE provision may be an important consideration for health systems and institutional leaders working to strengthen respiratory protection programs.

Conclusion

This overview shows that N95 respirator acceptability among HCWs is consistently lower than for surgical masks, driven primarily by physical discomfort rather than attitudinal resistance to respiratory protection. A persistent gap between endorsed and actual N95 respirator use was documented across settings, most markedly in dental practice. Duration of use was the key modifiable determinant of acceptability across all outbreak contexts. While most evidence comes from predominantly critically low methodological quality of included reviews, and thus, it requires cautious interpretation, there is consistency of findings across many reviews. Moreover, the findings from one high-quality review are highlighted, and it reports moderately high compliance and adherence of HCW to masks and also reports that respirators are consistently associated with more headaches, more self-reported difficulties in breathing and more discomfort. Our findings are important for decision-makers as they support the development of targeted actions on device design, fit testing, rest break policy, and equitable PPE

supply to bridge the gap between HCWs' intent to protect themselves and their ability to sustain N95 respirator use in practice.

Figure 1. PRISMA Flowchart of included studies



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UNITY HEALTH TORONTO

UNIVERSIDAD DE ANTIOQUIA
Facultad de Medicina

Unidad de Evidencia y Deliberación para la toma de decisiones
UNED

APPENDIX 1 SEARCH STRATEGIES

Medline (OVID)

Database(s): **Ovid MEDLINE(R) ALL** 1946 to February 05, 2026
Search Strategy:

#	Searches	Results
1	N95 Respirators/	427
2	(N95* or N-95* or N97* or N-97* or N99* or N-99* or DS2* or DS-2* or KN95* or KN-95* or KF94* or KF-94* or FFP2* or FFP-2* or P2? or P2s? or P-2? or P-2s? or PFF2* or PFF-2* or R95* or R-95*).ti,kf.	23464
3	((N95* or N-95* or N97* or N-97* or N99* or N-99* or DS2* or DS-2* or KN95* or KN-95* or KF94* or KF-94* or FFP2* or FFP-2* or P2? or P2s? or P-2? or P-2s? or PFF2* or PFF-2* or R95* or R-95*) and (mask* or facemask* or respirator*)).tw,kf.	5472
4	((mask* or facemask*) adj3 respirator*).tw,kf.	1319
5	(Filter* adj3 (facepiece respirator* or face-piece respirator*)).tw,kf.	556
6	or/1-5	28750
7	exp Health Personnel/	674629
8	exp Health Occupations/	1959982
9	Health Workforce/	15214
10	((health or healthcare or hospital* or clinic*) adj3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)).tw,kf.	454427
11	((medical or medicine) adj3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)).tw,kf.	74281
12	((long term care or longterm care or nursing home? or assisted living) adj3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)).tw,kf.	4449
13	(doctor* or physician* or nurse? or nursing or allied health* or clinician?).tw,kf.	1520111
14	Occupational Health/	38554
15	(occupational health or occupational safety or work* health or work* safety or employee* health or employee* safety).tw,kf.	40374
16	or/7-15	3756082
17	(systematic review or meta-analysis).pt.	406526
18	meta-analysis/ or systematic review/ or systematic reviews as topic/ or meta-analysis as topic/ or "meta analysis (topic)"/ or "systematic review (topic)"/ or exp technology assessment, biomedical/ or network meta-analysis/	454324
19	((systematic* adj3 (review* or overview*)) or (methodologic* adj3 (review* or overview*))).ti,ab,kf.	463901
20	((quantitative adj3 (review* or overview* or synthes*)) or (research adj3 (integrati* or overview*))).ti,ab,kf.	22232
21	((integrative adj3 (review* or overview*)) or (collaborative adj3 (review* or overview*)) or (pool* adj3 analy*)).ti,ab,kf.	50630
22	(data synthes* or data extraction* or data abstraction*).ti,ab,kf.	56836
23	(handsearch* or hand search*).ti,ab,kf.	12339
24	(mantel haenszel or peto or der simonian or dersimonian or fixed effect* or latin square*).ti,ab,kf.	43958

25	(met analy* or metanaly* or technology assessment* or HTA or HTAs or technology overview* or technology appraisal*).ti,ab,kf.	15061
26	(meta regression* or metaregression*).ti,ab,kf.	20557
27	(meta-analy* or metaanaly* or systematic review* or biomedical technology assessment* or bio-medical technology assessment*).mp,hw.	625456
28	(medline or cochrane or pubmed or medlars or embase or cinahl).ti,ab,hw.	470738
29	(cochrane or (health adj2 technology assessment) or evidence report).jw.	23126
30	(comparative adj3 (efficacy or effectiveness)).ti,ab,kf.	23850
31	(outcomes research or relative effectiveness).ti,ab,kf.	12888
32	((indirect or indirect treatment or mixed-treatment or bayesian) adj3 comparison*).ti,ab,kf.	5332
33	(multi* adj3 treatment adj3 comparison*).ti,ab,kf.	348
34	(mixed adj3 treatment adj3 (meta-analy* or metaanaly*)).ti,ab,kf.	190
35	umbrella review*.ti,ab,kf.	3427
36	(multi* adj2 paramet* adj2 evidence adj2 synthesis).ti,ab,kf.	18
37	(multiparamet* adj2 evidence adj2 synthesis).ti,ab,kf.	20
38	(multi-paramet* adj2 evidence adj2 synthesis).ti,ab,kf.	16
39	or/17-38 [CDA SR/MA/HTA Search Filter]	910763
40	6 and 16 and 39	150
41	limit 40 to yr="2015 -Current"	144
42	limit 41 to (english or french)	141

Embase (OVID)
Database(s): **Embase Classic+Embase** 1947 to 2026 February 04
Search Strategy:

#	Searches	Results
1	minimally 94 percent efficient filtering facepiece respirator/	3418
2	(N95* or N-95* or N97* or N-97* or N99* or N-99* or DS2* or DS-2* or KN95* or KN-95* or KF94* or KF-94* or FFP2* or FFP-2* or P2? or P2s? or P-2? or P-2s? or PFF2* or PFF-2* or R95* or R-95*).ti,kf.	30963
3	((N95* or N-95* or N97* or N-97* or N99* or N-99* or DS2* or DS-2* or KN95* or KN-95* or KF94* or KF-94* or FFP2* or FFP-2* or P2? or P2s? or P-2? or P-2s? or PFF2* or PFF-2* or R95* or R-95*) and (mask* or facemask* or respirator*)).ab.	7240
4	((mask* or facemask*) adj3 respirator*).tw,kf.	1642
5	(Filter* adj3 (facepiece respirator* or face-piece respirator*)).tw,kf.	523
6	or/1-5	40341
7	exp health care personnel/	2442339
8	medical profession/	32039
9	health workforce/	18145
10	((health or healthcare or hospital* or clinic*) adj3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)).tw,kf.	613979
11	((medical or medicine) adj3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)).tw,kf.	110395
12	((long term care or longterm care or nursing home? or assisted living) adj3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)).tw,kf.	5324

13	(doctor* or physician* or nurse? or nursing or allied health* or clinician?).tw,kf.	2149125
14	occupational health/	55795
15	(occupational health or occupational safety or work* health or work* safety or employee* health or employee* safety).tw,kf.	51309
16	or/7-15	4024851
17	(systematic review or meta-analysis).pt.	0
18	meta-analysis/ or systematic review/ or systematic reviews as topic/ or meta-analysis as topic/ or "meta analysis (topic)"/ or "systematic review (topic)"/ or exp technology assessment, biomedical/ or network meta-analysis/	828908
19	((systematic* adj3 (review* or overview*)) or (methodologic* adj3 (review* or overview*))).ti,ab,kf.	559828
20	((quantitative adj3 (review* or overview* or synthes*)) or (research adj3 (integrati* or overview*))).ti,ab,kf.	25559
21	((integrative adj3 (review* or overview*)) or (collaborative adj3 (review* or overview*)) or (pool* adj3 analy*)).ti,ab,kf.	71213
22	(data synthes* or data extraction* or data abstraction*).ti,ab,kf.	69287
23	(handsearch* or hand search*).ti,ab,kf.	15020
24	(mantel haenszel or peto or der simonian or dersimonian or fixed effect* or latin square*).ti,ab,kf.	59025
25	(met analy* or metanaly* or technology assessment* or HTA or HTAs or technology overview* or technology appraisal*).ti,ab,kf.	26698
26	(meta regression* or metaregression*).ti,ab,kf.	24988
27	(meta-analy* or metaanaly* or systematic review* or biomedical technology assessment* or bio-medical technology assessment*).mp,hw.	974042
28	(medline or cochrane or pubmed or medlars or embase or cinahl).ti,ab,hw.	606834
29	(cochrane or (health adj2 technology assessment) or evidence report).jw.	33540
30	(comparative adj3 (efficacy or effectiveness)).ti,ab,kf.	37244
31	(outcomes research or relative effectiveness).ti,ab,kf.	19727
32	((indirect or indirect treatment or mixed-treatment or bayesian) adj3 comparison*).ti,ab,kf.	9586
33	(multi* adj3 treatment adj3 comparison*).ti,ab,kf.	502
34	(mixed adj3 treatment adj3 (meta-analy* or metaanaly*)).ti,ab,kf.	270
35	umbrella review*.ti,ab,kf.	3643
36	(multi* adj2 paramet* adj2 evidence adj2 synthesis).ti,ab,kf.	42
37	(multiparamet* adj2 evidence adj2 synthesis).ti,ab,kf.	24
38	(multi-paramet* adj2 evidence adj2 synthesis).ti,ab,kf.	35
39	or/17-38 [CDA SR/MA/HTA Search Filter]	1302706
40	6 and 16 and 39	262
41	limit 40 to yr="2015 -Current"	246
42	limit 41 to (english or french)	244

Cochrane Database of Systematic Reviews (OVID)
Database(s): **EBM Reviews - Cochrane Database of Systematic Reviews** 2005 to January 28, 2026
Search Strategy:

#	Searches	Results

1	(N95* or N-95* or N97* or N-97* or N99* or N-99* or DS2* or DS-2* or KN95* or KN-95* or KF94* or KF-94* or FFP2* or FFP-2* or P2? or P2s? or P-2? or P-2s? or PFF2* or PFF-2* or R95* or R-95*).ti.	0
2	((N95* or N-95* or N97* or N-97* or N99* or N-99* or DS2* or DS-2* or KN95* or KN-95* or KF94* or KF-94* or FFP2* or FFP-2* or P2? or P2s? or P-2? or P-2s? or PFF2* or PFF-2* or R95* or R-95*) and (mask* or facemask* or respirator*)).ab.	8
3	((mask* or facemask*) adj3 respirator*).ti,ab.	3
4	(Filter* adj3 (facepiece respirator* or face-piece respirator*)).ti,ab.	0
5	or/1-4	11
6	((health or healthcare or hospital* or clinic*) adj3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)).ti,ab.	546
7	((medical or medicine) adj3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)).ti,ab.	17
8	((long term care or longterm care or nursing home? or assisted living) adj3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)).ti,ab.	4
9	(doctor* or physician* or nurse? or nursing or allied health* or clinician?).ti,ab.	1244
10	(occupational health or occupational safety or work* health or work* safety or employee* health or employee* safety).ti,ab.	23
11	or/6-10	1620
12	5 and 11	3

#	Query	Results
S29	S27 AND S28	48
S28	LA (english or french)	9,438,520
S27	S25 AND S26	56
S26	DT 2015-2026	4,958,394
S25	S6 AND S23 AND S24	62

S24	(MH "meta analysis" OR MH "systematic review" OR MH "Technology, Medical/EV" OR PT "systematic review" OR PT "meta analysis" OR (((TI systematic* OR AB systematic*) N3 ((TI review* OR AB review*) OR (TI overview* OR AB overview*))) OR ((TI methodologic* OR AB methodologic*) N3 ((TI review* OR AB review*) OR (TI overview* OR AB overview*)))) OR (((TI quantitative OR AB quantitative) N3 ((TI review* OR AB review*) OR (TI overview* OR AB overview*) OR (TI synthes* OR AB synthes*))) OR ((TI research OR AB research) N3 ((TI integrati* OR AB integrati*) OR (TI overview* OR AB overview*)))) OR (((TI integrative OR AB integrative) N3 ((TI review* OR AB review*) OR (TI overview* OR AB overview*))) OR ((TI collaborative OR AB collaborative) N3 ((TI review* OR AB review*) OR (TI overview* OR AB overview*))) OR ((TI pool* OR AB pool*) N3 (TI analy* OR AB analy*))) OR ((TI "data synthes*" OR AB "data synthes*") OR (TI "data extraction*" OR AB "data extraction*") OR (TI "data abstraction*" OR AB "data abstraction*")) OR ((TI handsearch* OR AB handsearch*) OR (TI "hand search*" OR AB "hand search*")) OR ((TI "mantel haenszel" OR AB "mantel haenszel") OR (TI peto OR AB peto) OR (TI "der simonian" OR AB "der simonian") OR (TI dersimonian OR AB dersimonian) OR (TI "fixed effect*" OR AB "fixed effect*") OR (TI "latin square*" OR AB "latin square*")) OR ((TI "met analy*" OR AB "met analy*") OR (TI metanaly* OR AB metanaly*) OR (TI "technology assessment*" OR AB "technology assessment*") OR (TI HTA OR AB HTA) OR (TI HTAs OR AB HTAs) OR (TI "technology overview*" OR AB "technology overview*") OR (TI "technology appraisal*" OR AB "technology appraisal*")) OR ((TI "meta regression*" OR AB "meta regression*") OR (TI metaregression* OR AB metaregression*)) OR (TI meta-analy* OR TI metaanaly* OR TI "systematic review*" OR TI "biomedical technology assessment*" OR TI "bio-medical technology assessment*" OR AB meta-analy* OR AB metaanaly* OR AB "systematic review*" OR AB "biomedical technology assessment*" OR AB "bio-medical technology assessment*" OR MW meta-analy* OR MW metaanaly* OR MW "systematic review*" OR MW "biomedical technology assessment*" OR MW "bio-medical technology assessment*") OR ((TI medline OR AB medline OR MW medline) OR (TI cochrane OR AB cochrane OR MW cochrane) OR (TI pubmed OR AB pubmed OR MW pubmed) OR (TI medlars OR AB medlars OR MW medlars) OR (TI embase OR AB embase OR MW embase) OR (TI cinahl OR AB cinahl OR MW cinahl)) OR (SO Cochrane OR SO health technology assessment OR SO evidence report) OR ((TI comparative OR AB comparative) N3 ((TI efficacy OR AB efficacy) OR (TI effectiveness OR AB effectiveness))) OR ((TI "outcomes research" OR AB "outcomes research") OR (TI "relative effectiveness" OR AB "relative effectiveness")) OR (((TI	391,526

	indirect OR AB indirect) OR (TI "indirect treatment" OR AB "indirect treatment") OR (TI mixed-treatment OR AB mixed-treatment) OR (TI bayesian OR AB bayesian)) N3 (TI comparison* OR AB comparison*)) OR ((TI multi* OR AB multi*) N3 (TI treatment OR AB treatment) N3 (TI comparison* OR AB comparison*)) OR ((TI mixed OR AB mixed) N3 (TI treatment OR AB treatment) N3 ((TI meta-analy* OR AB meta-analy*) OR (TI metaanaly* OR AB metaanaly*))) OR (TI "umbrella review*" OR AB "umbrella review*") OR ((TI multi* OR AB multi*) N2 (TI paramet* OR AB paramet*) N2 (TI evidence OR AB evidence) N2 (TI synthesis OR AB synthesis)) OR ((TI multiparamet* OR AB multiparamet*) N2 (TI evidence OR AB evidence) N2 (TI synthesis OR AB synthesis)) OR ((TI multi-paramet* OR AB multi-paramet*) N2 (TI evidence OR AB evidence) N2 (TI synthesis OR AB synthesis)) [CDA SR/MA/HTA Search Filter]	
S23	S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22	1,565,963
S22	TI ("occupational health" or "occupational safety" or "work* health" or "work* safety" or "employee* health" or "employee* safety") OR AB ("occupational health" or "occupational safety" or "work* health" or "work* safety" or "employee* health" or "employee* safety")	16,067
S21	(MH "Occupational Health")	35,252
S20	TI (doctor* or physician* or nurse# or nursing or "allied health*" or clinician#) OR AB (doctor* or physician* or nurse# or nursing or "allied health*" or clinician#)	939,623
S19	TI ("assisted living" N3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)) OR AB ("assisted living" N3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*))	147
S18	TI ("nursing home#" N3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)) OR AB ("nursing home#" N3 (personnel or staff* or employee* or professional* or provider* or worker*	2,652

	or workforce* or work force*))	
S17	TI ("longterm care" N3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)) OR AB ("longterm care" N3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*))	Display
S16	TI ("long term care" N3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*)) OR AB ("long term care" N3 (personnel or staff* or employee* or professional* or provider* or worker* or workforce* or work force*))	Display
S15	TI (medicine N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*")) OR AB (medicine N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*"))	Display
S14	TI (medical N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*")) OR AB (medical N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*"))	Display
S13	TI (clinic* N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*")) OR AB (clinic* N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*"))	Display
S12	TI (hospital* N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*")) OR AB (hospital* N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*"))	Display
S11	TI (healthcare N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*")) OR AB (healthcare N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*"))	Display
S10	TI (health N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*")) OR AB (health N3 ((personnel or staff* or employee* or professional* or provider* or worker* or workforce* or "work force*"))	Display
S9	(MH "Workforce")	Display
S8	(MH "Health Occupations")	2,298
S7	(MH "Health Personnel+")	Display

S6	S1 OR S2 OR S3 OR S4 OR S5	Display
S5	TI (Filter* N3 (facepiece respirator* or face-piece respirator*)) OR AB (Filter* N3 (facepiece respirator* or face-piece respirator*))	Display
S4	TI ((mask* or facemask*) N3 respirator*) OR AB (mask* or facemask*) N3 respirator*))	Display
S3	AB ((N95* or N-95* or N97* or N-97* or N99* or N-99* or DS2* or DS-2* or KN95* or KN-95* or KF94* or KF-94* or FFP2* or FFP-2* or P2# or P2s# or P-2# or P-2s# or PFF2* or PFF-2* or R95* or R-95*) and (mask* or facemask* or respirator*))	Display
S2	TI (N95* or N-95* or N97* or N-97* or N99* or N-99* or DS2* or DS-2* or KN95* or KN-95* or KF94* or KF-94* or FFP2* or FFP-2* or P2# or P2s# or P-2# or P-2s# or PFF2* or PFF-2* or R95* or R-95*)	Display
S1	(MH "N95 Respirators")	Display

APPENDIX 2. FULL-TEXT ARTICLES EXCLUDED WITH REASONS FOR EXCLUSION

Databases		
First author, year	**Name**	**Exclusion reason**
MacIntyre, 2020	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	Wrong outcomes
Wu, 2020	A systematic review and meta-analysis of the efficacy of medical masks and N95 respirators for protection against respiratory infectious diseases, including COVID-19 in medical staff	Wrong outcomes
Russo, 2024	A Systematic Review of the impact of wearing medical face masks on healthcare communication and doctor-patient relationship	Wrong study design (protocol)
Zainab, 2024	Barriers and facilitators to healthcare workers' adherence to infection prevention and control measures in the Middle East	Wrong study design (protocol)
Calo, 2020	Burden, risk assessment, surveillance and management of SARS-CoV-2 infection in health workers: A scoping review	Wrong outcomes
Barycka, 2020	Comparative effectiveness of N95 respirators and surgical/face masks in preventing airborne infections in the era of SARS-CoV2 pandemic: A meta-analysis of randomized trials	Wrong outcomes
Gul, 2020	COVID-19 and dermatology	Wrong outcomes
Boskoski, 2020	COVID-19 pandemic and personal protective equipment shortage: protective efficacy comparing masks and scientific methods for respirator reuse	Wrong outcomes
Rocha, 2020	COVID -19: pressure injury prevention measures occurred by individual protection equipment in health professionals	Wrong Language
Wilcha, 2021	Does Wearing a Face Mask During the COVID-19 Pandemic Increase the Incidence of Dermatological Conditions in Health Care Workers? Narrative Literature Review	Wrong study design
Bakhit, 2020	Downsides of face masks and possible mitigation strategies: a systematic review and meta-analysis [preprint]	Duplicate
Long, 2020	Effectiveness of N95 respirators versus surgical masks against influenza: A systematic review and meta-analysis	Wrong outcomes
Lassing, 2024	Effectiveness of surgical masks in preventing respiratory infections among healthcare workers: a scoping review	Wrong publication type (abstract)
Gagnon, 2025	Effectiveness of using full personal protective equipment in reducing the transmission of SARS-CoV-2 in health care workers: A systematic review	Wrong outcomes
Shekaraiah, 2024	Effect of Face Mask on Voice Production During COVID-19 Pandemic: A Systematic Review	Wrong intervention
Chou, 2020	Epidemiology of and Risk Factors for Coronavirus Infection in Health Care Workers; A Living Rapid Review	Wrong outcomes

Ching-Yuk, 2025	Face Mask Compliance among Healthcare Workers, Healthcare Students and the General Public Before, During and After COVID-19: A Systematic Review Protocol on Observational Studies	Wrong study design (protocol)
Fouladi Dehaghi, 2020	Face masks vs. COVID-19: a systematic review	Wrong outcomes
Yousra, 2024	Health effects of facemasks used during COVID-19 pandemic on healthcare workers	Wrong study design (protocol)
Guleria, 2022	Impact of prolonged wearing of face masks - medical and forensic implications	Wrong study design
Bartoszko, 2020	Medical masks vs N95 respirators for preventing COVID-19 in healthcare workers: A systematic review and meta-analysis of randomized trials	Wrong outcomes
Collins, 2021	N95 respirator and surgical mask effectiveness against respiratory viral illnesses in the healthcare setting: A systematic review and meta-analysis	Wrong outcomes
Sawada, 2023	Occupational Skin Dermatitis among Healthcare Workers Associated with the COVID-19 Pandemic: A Review of the Literature	Wrong study design
Ayu, 2021	Personal protective equipment and nurse self-efficacy due to Coronavirus disease-19 pandemic: A systematic review	Wrong outcomes
Verbeek, 2020	Personal protective equipment for preventing highly infectious diseases due to exposure to contaminated body fluids in healthcare staff	Wrong outcomes
Tian, 2020	Personal protective equipment (PPE) and infection among healthcare workers – what is the evidence? [preprint]	Wrong study design
Jefferson, 2020	Physical interventions to interrupt or reduce the spread of respiratory viruses	Duplicate
Tom, 2020	Physical interventions to interrupt or reduce the spread of respiratory viruses. Part 1 - Face masks, eye protection and person distancing: systematic review and meta-analysis	Wrong study design
Kisielinski, 2023	Physio-metabolic and clinical consequences of wearing face masks-Systematic review with meta-analysis and comprehensive evaluation [RETRACTED PUBLICATION]	Wrong study design
Arora, 2020	Real-world assessment, relevance, and problems in use of personal protective equipment in clinical dermatology practice in a COVID referral tertiary hospital	Wrong study design
Abdelrahman, 2020	Recommended operating room practice during the COVID-19 pandemic: systematic review	Wrong outcomes
Muñoz-Sánchez, 2019	Respiratory protection measures anti-tuberculosis in health personnel: integrative review	Wrong Language
Khalil, 2021	SARS-CoV-2, surgeons and surgical masks	Wrong study design
Round, 2021	Speech intelligibility in respiratory protective equipment - Implications for verbal communication in critical care	Wrong study design
Atz dos Santos, 2025	Strategies adopted by health care settings globally to prevent transmission of viral respiratory infections in health care workers: a systematic review	Wrong study design (protocol)
Violante, 2020	Surgical masks vs respirators for the protection against coronavirus infection: state of the art	Wrong study design
Seyedalinaghi, 2023	The Effectiveness of Face Masks in Preventing COVID-19 Transmission: A Systematic Review	Wrong outcomes

Rakhman, 2024	The Impact of Prolonged Face Mask Used on Halitosis: Insight from a Systematic Review	Wrong study design (protocol)
Aghazadeh, 2024	What special precautions are required while anesthetizing COVID-19 patients in the operation room?	Wrong study design
Hegde, 2020	Which type of personal protective equipment (PPE) and which method of donning or doffing PPE carries the least risk of infection for healthcare workers?	Wrong publication type
Grey Lit Websites		
Provincial Infection Control Network of British Columbia (PICNet), 2024	Skin protection for PPE use: for healthcare workers	Wrong study design
LeBlanc, 2020	Prevention and Management of Personal Protective Equipment Skin Injury: Update 2020	Wrong study design
Public Health Ontario, 2025	Best practices for the prevention of acute respiratory infection transmission in all health care settings	Wrong Outcomes
World Health Organization, 2020	Mask use in the context of COVID-19	Wrong study design
MacIntyre, 2025	The role of masks and respirators in preventing infections in healthcare and community settings	Wrong Outcomes
World Health Organization, 2021	Use of medical and non-medical/fabric masks for community outreach activities during the COVID-19 pandemic	Wrong study design
World Health Organization, 2020	Rational use of personal protective equipment for COVID-19 and considerations during severe shortages	Wrong study design
European Centre for Disease Prevention and Control, 2021	Infection prevention and control and preparedness for COVID-19 in healthcare settings: Sixth Update	Wrong study design
Institut national de santé publique du Québec (INSPQ), 2022	Evaluation of Disinfection Options for N95 Filtering Facepiece Respirators in the Context of the Pandemic	Wrong study design
Institut national de santé publique du Québec (INSPQ), 2023	SRAS-CoV-2 : Mesures de prévention et contrôle des infections pour les soins à domicile recommandations intérimaires	Wrong study design
Institut national de santé publique du Québec (INSPQ), 2021	SRAS-CoV-2 : Avis du CINQ sur la protection respiratoire des travailleurs de la santé dans les milieux de soins	Wrong study design
European Centre for Disease Prevention and Control, 2023	Considerations for infection prevention and control practices in relation to respiratory viral infections in healthcare settings	Wrong study design
NHS National Services Scotland, 2023	National Infection Prevention and Control Manual. Chapter 1: Standard Infection Control Precautions	Wrong study design
Antimicrobial Resistance and Healthcare Associated Infection (AHRAI Scotland), 2025	Personal Protective Equipment (PPE): Eye/Face Protection Literature Review	Wrong intervention
Antimicrobial Resistance and Healthcare Associated	Standard Infection Control Precautions (SICPs) and Transmission Based Precautions (TBPs) literature review Surgical Face Masks	Wrong intervention

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APPENDIX 3. DETAILED SUMMARY OF INCLUDED REVIEWS ORGANIZED BY OUTCOME

Table 1. Acceptability

Acceptability						
Author, Year Country Type of review	**Year of last search Purpose of the review**	**No. of Primary Studies Included in Review / No. of primary studies of interest to our PICO Country/ies**	**Populations and setting Disease/ Outbreak context**	**Interventions**	**Main findings**	**Evaluation of the quality of the review**
Alberta Health Services, 2020 Canada Rapid review	NR, studies published between 2003 and 2020. This report is intended to collate evidence to inform the PPE Task Force on whether current PPE guidelines, in respect to exposure to a probable or confirmed COVID-19 patient, should be modified.	59 / 35 Canada, UK, USA, Italy, China, Singapore, France, Australia.	Patients diagnosed with and being treated for influenza, SARS-CoV-1, SARS-CoV-2, MERS, and RSV Acute care, long-term care healthcare workers (HCW).	Full PPE, continuous masking, and continuous full PPE patient isolation (assumption that HCWs wearing either full PPE, continuous masking, and continuous full PPE).	**Compliance** Inconclusive results. Arasli, 2020 Skin reactions from the gloves, gowns, or face shields that were also worn by nurses for long hours during the existing pandemic discouraged nurses from using them. Hines, 2020 Most respondents did not find that the use of respirators and PPE impacted their ability to perform patient care (62%) or that it was inconvenient (51%). However, if respirator use interfered with their ability to perform care, it would influence their compliance with respirator use. More PAPR users (27%) than N95 users (17%) and	Critically Low

			N (14318) NR Context: NR		elastomeric respirator users (16%) agreed that respirator use interferes with patient care. **Comfort** Seven studies assessed comfort; most did not specify the type of PPE evaluated. Ciris Yildiz, Ulasli Kaban, and Tanriverdi, 2020 A total of 124 participants reported that the frequency of mask use decreased due to discomfort; however, it was not specified whether the mask used was exclusively an N95 respirator. Gupta, Singh, and Gupta, 2020 56% of participants reported that the mask was very uncomfortable due to pain caused by the elastic bands. Yánez Benítez, 2020 66% of participants reported a decrease in overall comfort, 82% indicated increased surgical fatigue, and 48% agreed that PPE use influenced their decision-making process. Kuo, 2020 The main stressor for hospital staff was discomfort caused by protective equipment. Lawrence, 2020 Most participants rated the comfort associated with the half-face mask (FFP3 or FFP2) as good, with a higher proportion reporting comfort compared with those using full-face masks.	

					Corley, Hammond, and Fraser, 2009 A qualitative study of Australian nurses following the H1N1 influenza pandemic suggested that physical discomfort of PPE may be overlooked by providers as a trade-off for what is perceived as adequate protection against the infectious agent. **Tolerability** Corley, Hammond, and Fraser, 2009 The wearing of PPE was generally tolerated by most staff because it was considered a necessary protective measure. One participant stated that “using PPE was really good.” Nevertheless, physical discomfort associated with PPE emerged as a key theme. Khoo, 2005 The majority of respondents who used both the 3M and Stryker PAPR systems reported that they were at least tolerable in terms of comfort. **Adherence** Daugherty, 2009 Respondents who believed that adherence posed an inconvenience to their work routine were less likely to report high levels of adherence (odds ratio 0.42; 95% CI 0.22–0.80). However, the belief that PPE interferes with quality of care was not associated with reduced adherence. Kuo, 2020 PPE discomfort is a source of stress for nurses, which may affect adherence.	

					Ciris Yildiz, Ulasli Kaban, and Tanriverdi, 2020 Physical discomfort associated with PPE contributed to reduced frequency of mask use, suggesting an impact on adherence. Houghton, 2020 Physical discomfort associated with PPE was reported as a factor that impacts adherence.	
Arikpo, 2025 Nigeria Qualitative evidence synthesis	05/09/2022 This review aimed to (1) synthesized available qualitative research exploring the perceptions and experiences of health and care workers on the use of PPE and physical distancing interventions in healthcare settings in the context of COVID-19 and (2) identify the contexts and conditions that facilitate or hinder uptake and adherence to these interventions.	19 / 14 India, Iran, Indonesia, China, Turkey, Australia, Finland, Portugal, Italy, Spain, UK, US, Belgium, France, Luxembourg, S Korea, Ireland	Health and care workers involved in patient care and those who are not involved in patient care. Healthcare policymakers. Health facility clients (including residents of care homes, recipients of care – inpatients, and outpatients) and visitors. Community members – general public and members of households.	Physical barriers and distancing for infection prevention, including PPEs (e.g., face masks, coveralls, gowns, shoe covers, N95 respirators, gloves, goggles, face shields) Physical distancing (e.g., keeping a distance of a least 1 m or 2 m between patients or persons) Engineering controls (air cleaning and purifier technologies; spatial separation using physical barriers).	**Perception of security** Three studies assessed perceptions of security through interviews: two reported unfavorable perceptions and one reported favorable perception. Broom, 2022 Participants reported anxiety and insecurity regarding the level of protection provided by PPE. Hoernke, 2021 Participants expressed concerns about the level of protection and their role during the pandemic. One interviewee stated: “The first thing to do is I … don’t make them feel like a pawn in a bigger game, because sometimes we feel like we are obliged to do stuff to save the rest, but we are part of the rest too.” Sivaraman, 2022 Masks and PPE were perceived as contributing to a safety climate that allowed HCWs to deliver optimal care. One participant explained: “…[T]he face mask contributes to creating a safety climate and protecting clients’ and therapists’ physical health, making it possible to do face-to-face therapy.” Familiarity with masks and other PPE helped HCWs adapt to the COVID-19 context.	Critically Low

			N (633) Health facilities and care home Context: COVID-19		Aggregative (Cross-study observation) There was rampant comparison of PPE across healthcare settings, consequently, health and care workers in settings without hazmat suits had heightened perceptions of susceptibility and risk and felt less prioritized compared to health and care workers from other settings.	
Bakhit, 2021 Australia Systematic review and meta-analysis	18/05/2020 Anecdotal evidence, and some studies, suggest that there may be a variety of downsides arising from mask use, including discomfort, a sense of difficulty breathing, and communication problems particularly for those who use lip reading. The aim is to systematically identify and summarize these downsides, to assist policymakers when formulating mask-wearing policies in public settings. The authors also discuss potential strategies to mitigate downsides of mask-wearing.	37 / 10 USA, Australia, Canada, France, China, Hong Kong, Singapore, Japan, Taiwan, Vietnam, Thailand, Germany	People of any age or gender, in any setting N (8547)	Surgical masks, N95 masks, cloth masks (both homemade and commercially available).	**Adherence** Four studies (Bryce, 2008; MacIntyre, 2011; MacIntyre, 2013; Radonovich, 2019) with 7960 participants compared adherence for different face masks. Face mask wear was significantly higher in the surgical/medical face mask group than in the N95/P2 group, OR=1.26 (95% CI 1.08 to 1.46, p<0.01). Heterogeneity was very low (I^2=27%). But HCWs were not separated from the general population. Comparison of adherence to surgical/medical face masks vs N95/P2 masks: Bryce, 2008 not specified MacIntyre, 2011 OR 1.30 (1.01-1.67) IC 95% MacIntyre, 2013 OR 1.47 (1.16-1.87) IC 95% Radonovich, 2019 OR 1.09 (0.91- 1.31) IC 95%. **Misuse** Mask misuse appears less studied than other harms and discomforts. A study of 10 nurses observed for 10 min/ hour over two shifts found that they touched their face two to three times per hour, their mask five times per hour and their eyes once per 2 hours, when observed by students (Rebmann, 2013).	Low

Balestracci, 2023 Italy Systematic review	1/01/2021 To assess the safety, the risks and/or the respiratory physiological impact of FMs in age ranges or disease categories.	63 / 8 NR	Special populations (including HVCW) N (NR) NR	Respiratory protective equipment	**Comfort** Or, 2018 A Personal Respirator Sampling Test (PRST) and usability questionnaire were conducted in 84 nursing students, the respirators resulted comfortable at warm temperatures of 20–24 °C. (Or, 2018). Aggregative In general, evidence demonstrates that benefits of wearing face masks exceed discomfort; anyway an “air break” after 1–2 hours consecutively of mask-wearing can be a good practice for people with respiratory function compromised by diseases or in particular conditions (i.e. pregnancy, epilepsy, etc.).	Critically Low
Burton, 2021 UK Rapid review	11/05/2020 To synthesize evidence concerning the range of filtering respirators suitable for patient care and guide the selection and use of different respirator types	39/13 NR	Health care workers N (2657) NR	Respirators Use of disposable respirators Use of reusable respirators Selection and implementation of different respirator types of Existing respirator standards	**Comfort/sense of protection/Tolerability** Three studies evaluated comfort (Bryce, 2008; Hines, 2019; Radonovich, 2009). Bryce, 2008 Comfort and usability of filtering facepiece respirators (FFRs) were evaluated using self-reported Likert scale surveys. Three surveys with more than 100 participants reported various effects on comfort and usability in 10%–60% of users, although the specific effects were not detailed. Hines, 2019 Comfort and sense of protection were evaluated using a self-reported Likert scale. Comfort ranking was FFR > EHFR > PAPR, whereas the sense of protection ranking was EHFR > PAPR > FFR. The study included 1,152 HCWs from multiple hospitals in two U.S. states (approximately 10% of the invited sample). Among respondents, 53% regularly used FFRs, 24% EHFRs, and 23% PAPRs. Perceived discomfort ranged from 15% to 30% depending on respirator type, with lower discomfort reported for FFRs and higher for EHFRs. Approximately 70%–80% of HCWs reported confidence in the protection provided by their respirator, with the highest confidence among EHFR users.	Critically Low

					Tolerability Radonovich,2009 Comfort and tolerated wear time were evaluated for eight hours of respirator use. Only 55% of participants were able to tolerate eight hours of use with PAPRs or FFRs with an expiratory valve, compared with 30%–40% for other respirator types. Approximately 30% of participants reported self-reported discomfort across respirator types, although heat discomfort was less frequently reported with PAPRs. Rebmann, 2013 Tolerance time for filtering facepiece respirators (FFRs) was evaluated. Nine out of ten participants were able to wear the respirator for more than three hours before requiring a break. Approximately two protocol violations per hour worked were reported. Radonovich, 2019 Respirator tolerability was evaluated using the R-COMFI score. Results suggested a probable meaningful improvement in tolerability with newer respirator devices, indicating that design improvements may enhance user comfort and tolerability. **Impact on comfort / HCW and organization perceptions regarding use** Findings from an aggregative study. Comfort: Discomfort reported in 15%–40% users. Higher with EFR/PAPR than FFR. More than half of users unable to wear for a full 8-hour shift. HCWs and organization perceptions regarding use: HCW balance between discomfort and extra protection. Both HCWs and organizations indicate important the importance of practical issues (storage, access) and social context of norms and culture. Adherence to standards in practice and the effect of training. Failure to follow guidelines for safe use is common both in donning / doffing and during use.	

					Repeated training appears to be necessary to ensure continuing safe respirator fit.	
CDC, 2023 USA Systematic Review and Metanalysis	03/08/2023 HICPAC's Isolation Guideline Update Workgroup requested CDC conduct a systematic literature review to answer the question: for healthcare personnel caring for patients with respiratory infections, what is the effectiveness of medical/surgical masks compared with N95 respirators in preventing infection?	40/27 Indonesia, France, Canada, Thailand, The United States, Switzerland, India, Pakistan, Israel, Egypt, China, Greece, Italy	Healthcare personnel N (NR) They are mentioned emergency departments and respiratory wards of included hospitals, medical units, and pediatric units of eight tertiary care hospitals, outpatient medical centers, including primary care facilities, dental clinics, adult and pediatric clinics, dialysis units, urgent care facilities, emergency transport services, 29 health care facilities (27 acute care hospitals and 2	N95 respirators and face protection with similar levels of protection (e.g., FFP2/FFP3	**Compliance** Five studies evaluated compliance; three used both self-reported and observational measures, one relied on self-report only, and one did not report the method. MacIntyre, 2011 Mask compliance: N95 fit-tested respirator: 74% (95% CI: 70%78%) N95 non-fit-tested respirator: 68% (95% CI: 64%-73%) Medical mask: 76% (95% CI: 72%-79%) Anshory, 2022 Mask compliance, n/N (%): Often: 116/184 (63%) Sometimes: 51/184 (27.7%) Never: 17/184 (9.2%) Loeb, 2009 The auditor assessed compliance for one room entry per observation and full compliance in the room was not assessed. Mask compliance: Intervention N95: 6/7 (85.7%) Control surgical mask: 11/11 (100%) MacIntyre, 2013 Fit-tested N95 respirator (N95 Particulate Respirator, 1860) Medical/surgical mask (3M Standard Tie-On Surgical Mask 1817) Self-reported compliance: N95 respirator: 333/581 (57%) Targeted N95 respirator: 422/516 (82%) Medical mask: 380/572 (66%) $p < 0.001$ Fit test failure: N95 and Targeted N95 respirator: 28/1,086 (2.6%)	Low

			long-term care facilities).		Radonovich, 2019 Mask compliance on daily surveys and study personnel observed participants' mask-wearing behaviors as they entered and exited patient care rooms by conducting random, unannounced, inconspicuous visits. Mask compliance on daily surveys: "Always" Intervention: 14,566/22,330 (65.2%) Control: 15,186/23,315 (65.1%) "Sometimes" Intervention: 5,407/22,330 (24.2%) Control: 5,853/23,315 (25.1%) "Never" Intervention: 2,272/22,330 (10.2%) Control: 2,207/23,315 (9.5%) "Do not recall" Intervention: 85 (0.4%) Control: 69/23,315 (0.3%) Observed mask compliance: Intervention: 40.6% Control: 33.5% p = 0.02 **Adherence** Loeb, 2022 Self-reported adherence: Measured using weekly self-reporting for all participants. Intervention: Always: 91.2% Sometimes: 6.5% Never: 1.1% Do not recall: 1.1% Control: Always: 80.7% Sometimes: 13.7% Never: 4.3% Do not recall: 1.3% Audited adherence: Conducted when feasible, audits were done at 3 hospitals in Pakistan and 6 in Egypt where 20% of shifts were randomly selected and trial participants were observed.	

					Intervention: 116/118 (98.3%) Control: 113/117 (96.6%) p = NR	
Fakherpour, 2023 Iran Systematic review	21/03/2023 The authors systematically reviewed the studies performed on respirator fitting and affective factors during COVID-19	137 / 9 The United States, Australia, United Kingdom, Canada, China, Iran, Japan, South Korea, Italy, India, Germany, Spain, Brazil, the Netherlands, Singapore, Turkey, Saudi Arabia, France, Malaysia, Pakistan, and Switzerland	HCWs N = 2,888 NR	N95 respirators FFP2 KN95 NIOSH	**Preference subjective** Bodas, 2022 During a fit test, the overall subjective rating for the CE MSK-002 was significantly higher for BYD ($p < 0.001$) Chan, 2021 The subjects' perception improved from 39.2% (20/51) pre-test (before fit testing) to 81.8% (36/44) post-test (after fit testing). **Comfort and Usability** Cloet, 2022 The results of the activity and usability assessment indicated that the KN95 had the highest usability score due to its loose-fitting. MNmask v2 had higher usability scores (subjective discomfort, wear efficiency, and speech intelligibility) and breathability than MNmask v1, although it showed lower stability because the paracord bands increased wear efficiency but reduced stability. Ng, 2022 Passing rates were 65.0% for semi-rigid cup respirators, 32.4% for flat-fold respirators, 59.2% for duckbill respirators, and 96.4% for three-panel flat-fold respirators. The three-panel flat-fold respirators had the highest comfort and usability scores, while semi-rigid cup respirators had the lowest. Cloet, 2022 The passing rates and mean FFs were MNmask v1: 22.22%, 93.32±141.35; MNmask v2: 77.78%, 438.0±436.15; KN95: 0%, 4.86±2.15. Participants rated MNmask v1 as the most fitting (confidence in mask seal) and MNmask v2 as the most stable. Fit, comfort, material, and design were identified as key factors affecting user experience.	Critically Low

					Suen, 2022 Before and after nursing procedures, 69 (66.3%) participants passed the best-fitting 3M FFR and 82 (78.8%) passed the nanofiber FFR. The nanofiber FFR had significantly higher usability than the 3M FFR (facial heat, breathability, facial pressure, speech intelligibility, itchiness, mask stability, comfort on ear lobe, and overall comfort) ($p < 0.001$). **Safety perceptions** Clark, 2021 After fit testing, participants completed a safety perception questionnaire. All participants knew how to wear the N95 respirator and 41 (63%) reported that their safety perceptions changed after the fit test. **Knowledge and attitudes** Williams, 2021 After online training and quantitative fit testing, participants' knowledge, donning and doffing skills, and user seal checks (USCs) improved significantly ($p < 0.01$). Yeon, 2020 Knowledge and attitudes toward PPE use were assessed before fit testing. There were no significant differences between groups. Fit test pass rates were 68% in the experimental group and 50% in the control group ($p = 0.354$).	
Franco, 2021 Brazil Scoping review	12/06/20 To map the use of PPE by healthcare professionals to combat COVID-19 in healthcare settings.	13 / 11 90 different countries across Africa, Asia, Europe, North America, Oceania, and South America.	HCWs N = 142,870 ICU; Hospitals and clinics (includes home care clinics, community pharmacies and health districts); Isolation wards;	FFP2/N95 mask FFP3 (or equivalent standard) Surgical mask Face shields/goggles Breathing certified masks PPE (including masks)	**Perceived Protection** Felice, 2020 Most reported having access to PPE, but few considered it adequate and of good quality Delgado, 2020 Most participants reported having access to personal protective equipment (PPE)PPE; however, many healthcare professionals indicated that they did not have the equipment required and recommended by the World Health Organization (WHO)	Critically Low

			Emergency rooms; Frontline; Pre-hospital and hospital care; Inpatient and outpatient. Context: Covid-19		**Access and use** El-Boghdadly, 2020 There was insufficient use of PPE, and the combinations of protective equipment varied, making it impossible to assess whether the equipment was used according to World Health Organization (WHO) standards. Nguyen, 2020 There is compelling evidence that the availability and adequate quality of personal protective equipment (PPE)PPE reduce the risk of COVID-19 infection; however, reuse or misuse may pose a high risk of self-contamination during donning and doffing, particularly as a result of prolonged wear. **Adherence** Jin, 2020 In a retrospective report, healthcare professionals reported consistently adhering to hand hygiene and to the procedures for donning and removing protective equipment. Most participants indicated that they always wore masks and gloves.	
Iannone, 2020 Italy Rapid Review	21/3/2020 They authors conducted a systematic review aimed at assessing the efficacy of N95 respirators versus surgical masks for the prevention of respiratory tract infections transmission among HCWs.	4 / 1 Canada, China, USA	HCWs N = 8,736 Hospitals, ED departments and respiratory wards Context: NR	Fit-tested N95 respirator Nonfit-tested N95 respirator Surgical mask	**Comfort** MacIntyre, 2011 In the N95 respirators group the 47.7% (out of 949 HCW) reported no problems associated with the using of respirator but 41.9% stated that was uncomfortable vs In surgical mask group, the 85.5% (out of 492 HCW) reported no problems associated with the using of masks but a 9·8% stated that was uncomfortable. Discomfort was higher among HCWs wearing N95 respirators	Low

Jefferson, 2023 Canada Systematic review and meta-analysis	04/10/2022 To assess the effectiveness of physical interventions to interrupt or reduce the spread of acute respiratory viruses.	78 / 4 USA, Japan, China	General population (including HCWs)	N95/P2 respirators Medical/ surgical masks	**Adherence** Radonovich, 2019 Adherence for usage was high for all groups and was not significantly different among study arms. In the medical mask group, adherence was 76%, with an average use of 5 hours. In the fit-tested N95 group, adherence was 74%, with an average use of 5.2 hours, while in the non–fit-tested N95 group adherence was 68%, with an average use of 4.9 hours. Additionally, 89.4% of participants in the N95 group reported wearing the mask “always” or “sometimes,” compared with 90.2% in the medical mask (MM) group. Conversely, “never” wearing the mask was reported by 10.2% in the N95 group and 9.5% in the MM group. MacIntyre, 2011 Adherence to mask wearing was collected at exit interviews 4 weeks post-study. Adherence to mask or respirator use was reported to be associated with problems using the masks or respirators. Not wearing the mask was more common with N95 that than with medical mask. Loeb, 2009 A total of 18 episodes were reported. Among participants in the N95 group, 6 of 7 (85.7%) were wearing the assigned device, compared with 100% adherence in the comparison group. **Compliance** MacIntyre, 2013 Compliance was highest in the targeted N95 arm (82%; 422 of 516), followed by the medical mask arm (66%; 380 of 572) and the N95 arm (57%; 333 of 581); these differences were statistically significant (P < 0.001).	High

Schwarz, 2024 Germany Systematic review and meta-analysis	24/04/2023 The authors conducted an update of reports on the risk of SARS-CoV-2 transmission to caregivers in dental healthcare settings, now with a particular emphasis on infection control practices, in the examined facilities	29 / 3 Brazil, USA, Italy, Poland, Canada, UK, Germany, Russia, Qatar, Saudi- Arabia, Spain, Sweden, Iraq, France, Romania, Argentina, Peru, Czech Republic, Iran and Norway	Dental HCWs N = NR Outpatient settings Context: Covid-19	N95 FFP masks Surgical mask	**Use** Madathil, 2022 The study covered a period from July 29, 2020, through February 12, 2021, nearly all dentists were using either N95 respirators or surgical masks. Of note, the incidence proportion was lower with 1,084 per 100,000 of dentists as that of the general population at 1,864 per 100,000 people). Mksoud, 2022 The study included IgG antibody sampling more than one year after the start of the COVID-19 pandemic in Germany, showed that while only three quarters (74.2%) of DCW wore FFP masks, no difference in their SARS-CoV-2 prevalence could be shown to that of the general German population. Moraes, 2022 They found a prevalence of 27% among Brazil dentists, reported that only 69% of dentists wore N95 masks as of May 2021.	Critically Low
Wolf, 2022 Germany, Switzerland and Italy Scoping review	09/09/2021 Summarize dentists' risk awareness (e.g., how dentists assessed the risks inherent to their profession), usage of preventive measures (e.g., common or advanced preventive measures in dental health care and usage of PPE), and treatment of infected people during the pandemic, as dentists must understand the risks during such an extraordinary situation.	39 / 14 Austria, Brazil, China, Cyprus, Indonesia, India, Italy, Jordan, Lebanon, Mexico, Nepal, Pakistan, Saudi Arabia, Spain, Switzerland, Switzerland, Turkey, UAE	Oral health workers N = 12,612 NR Context: Covid-19	N95	**Recommendation and use of N95 masks** Ahmed, 2020 Recommend N95 use: 84%; Report N95 use: Not reported. Alduwayhi, 2020 Recommend N95 use: 79%; Report N95 use: 10%. Al-Khalifa, 2020 Recommend N95 use: 72%; Report N95 use: Not reported. Bakaeen, 2020 Recommend N95 use varied by region: Eastern Mediterranean (63.2%), Europe (41.6%), North America (67.8%), and Western Pacific (40.5%). Reported N95 use was 34.4% in Eastern Mediterranean, 8.3% in Europe, 16.4% in North America, and 25.3% in Western Pacific.	Low

					Bekes, 2020 Recommend N95 use: Not reported; Report N95 use: 89.7%. Kanaparthi, 2020 Recommend N95 use: 94.8%; Report N95 use: Not reported. Karayürek, 2020 Recommend N95 use: Not reported; Report N95 use: 47.6%. Khan, 2020 Recommend N95 use: 89.5%; Report N95 use: Not reported. Martinez-Beneyto, 2020 Recommend N95 use: 25.3%; Report N95 use: Not reported. Nasser, 2020 Recommend N95 use: 80%; Report N95 use: Not reported. Pandey, 2020 Recommend N95 use: 81.7%; Report N95 use: Not reported. Ravi, 2020 Recommend N95 use: 95%; Report N95 use: Not reported. Casillas Santana, 2020 Recommend N95 use: Not reported; Report N95 use: 70.2%. Aggregative 70.3% (SD 22.1%) of dentists considered it a good idea to wear N95 masks during the pandemic, while 37.7% (SD 27.6%) wore them (Table 6). Only in Europe, the Western Pacific, and Spain, did less than 50% of dentists think N95	

					masks should be worn [53,62]. The single country with the highest usage of these masks was Austria, where only 10.3% of dentists did not use them [20]. Despite the moderately high value of 67.8% in North America recommending the use of N95 masks, a small number of 16.4% used the masks [62].	

Table 2. Physical and psychological health outcomes

Physical and psychological health outcomes						
Author, Year Country Type of review	**Year of last search Purpose of the review**	**No. of Primary Studies Included in Review / No. of primary studies of interest to our PICO Country/ies**	**Populations and setting Disease/ Outbreak context**	**Interventions**	**Main findings**	**Evaluation of the quality of the review AMSTAR 2**
Alberta Health Services, 2020 Canada Rapid review	NR, studies published between 2003 and 2020. This report is intended to collate evidence to inform the PPE Task Force on whether current PPE guidelines, in respect to exposure to a probable or confirmed COVID-19 patient, should be modified.	59 / 35 Canada, UK, USA, Italy, China, Singapore, France, Australia.	Patients diagnosed with and being treated for influenza, SARS-CoV-1, SARS-CoV-2, MERS, and RSV Acute care, long-term care HCWs. N (14318) NR	Full PPE, continuous masking, and continuous full PPE patient isolation (assumption that HCW wears either full PPE, continuous masking, and continuous full PPE).	**Headaches** Pei, 2020 PPE-associated headaches reported by 128 participants (81.0%). Headache intensity was mild in 92 (71.9%). Associated symptoms included nausea/vomiting, photophobia, phonophobia, neck discomfort, and movement sensitivity. Farronato, 2020 Headaches, breathing difficulties, concentration problems, and exertion associated with FFP2/N95 respirator use. Breathing difficulties were at least moderate in 63.5% of the sample but were not correlated with the hours spent wearing N95/FFP2 respirators. These symptoms contributed to moderate impaired working ability in 85.5% of participants. Impaired working ability was strongly correlated with headaches ($\rho = 0.212$, $p < 0.01$), breathing difficulties ($\rho = 0.566$, $p < 0.01$), concentration problems ($\rho = 0.748$, $p < 0.01$), and exertion ($\rho = 0.620$, $p < 0.01$). Headaches were reported as one of the main outcomes related to FFP2 respirator wear.	Critically Low

					Lim, 2006 Headaches associated with N95 mask use. 79 participants (37.3%) reported headaches while wearing N95 masks; 27 37.3%) had pre-existing headaches and 52 (62.7%) had no prior history. Among those with headaches, 25 (31.6%) had migraine, 43 (54.4%) tension-type headaches, and 11 (13.9%) unspecified headaches. Pre-existing headaches (P = 0.041; OR = 1.97; 95% CI 1.03–3.77) and continuous wear of the N95 facemask (P = 0.053; OR = 1.85; 95% CI 0.99–3.43) were associated with headache occurrence. 26 (32.9%) experienced more than six headaches per month, 6 (7.6%) took sick leave due to headaches, and 47 (59.5%) required abortive analgesics. Ong, 2020 Headaches, nausea and/or vomiting, photophobia, phonophobia, neck discomfort, and movement sensitivity associated with PPE use. 128 (81.0%) reported de novo PPE-associated headaches when wearing N95 masks with or without protective eyewear. Headache intensity was mild in 92 of 128 (71.9%). Associated symptoms occurred in 30 (23.4%) participants. Headache onset occurred within <60 minutes for most respondents (104/128; 81.3%) and resolved within 30 minutes after PPE removal in most cases (113/128; 88.3% for N95 masks; 114/128; 89.1% for eyewear). Wearing N95 masks (OR 1.59; 95% CI 1.15–2.18; P < .001), protective eyewear (OR 1.60; 95% CI 1.13–2.25; P < .001), or both together (OR 1.50; 95% CI 1.09–2.07; P = .002) for >4 hours/day increased headache risk.	

					Skin reactions Atay & Cura, 2020 Redness of the cheeks, dryness of the mouth, redness of the bridge of the nose, and redness of ear flaps. Wearing PPE for >4 hours increased adverse effects: surgical mask use >4 h increased dry mouth (OR 1.47; 95% CI 1.01–2.13), gloves >4 h increased dry hands (OR 2.39), sweating (OR 3.03), and redness (OR 1.52). Goggles or face shields >4 h increased headache risk (OR 1.51). Wearing an N95 mask >4 h increased redness of cheeks (OR 1.6), dry mouth (OR 2.18), nasal bridge redness (OR 2.02), and ear redness (OR 3.44). dry mouth (OR 1.47; 95% CI 1.01–2.13), gloves >4 h increased dry hands (OR 2.39), sweating (OR 3.03), and redness (OR 1.52). Goggles or face shields >4 h increased headache risk (OR 1.51). Wearing an N95 mask >4 h increased redness of cheeks (OR 1.6), dry mouth (OR 2.18), nasal bridge redness (OR 2.02), and ear redness (OR 3.44). Lin, 2020 Adverse skin reactions. 280 respondents (74.5%) reported adverse skin reactions, a rate higher than occupational contact dermatitis under normal conditions (31.5%) and higher than rates reported during the SARS outbreak (21.4–35.5%). Wearing full-body PPE for >6 h/day was associated with increased adverse skin reactions (OR 4.26; $P < 0.001$). The most commonly affected areas were the hands (84.6%), cheeks (75.4%), and nasal bridge (71.8%). Limiting PPE wearing time to ≤6 hours per day and promoting proper PPE education were suggested to reduce these reactions. Bothra, 2020 Retro auricular dermatitis, sweat dermatitis, and dermatoses related to mask ear loops. All 14 cases were diagnosed with retro auricular dermatitis. N95 masks were the most commonly used mask in 35.7% of patients; latex straps caused dermatoses in 4 (28.5%) patients. Chou, 2020 Discomfort, breathing difficulties, and skin events were	

					reported with PPE use; evidence regarding differences between N95 and surgical masks was mixed. Foo, 2006 Acne, facial itch, dry skin, itch, wheals, and rash. Adverse skin reactions were reported by 109 (35.5%) of 307 staff who used masks regularly. Reactions included acne (59.6%), facial itch (51.4%), and rash (35.8%). Adverse reactions were also reported by 64 (21.4%) of 299 staff using gloves and 4 (1.6%) of 258 staff using gowns. N95 masks were worn 8 h/day on average over 8.4 months; gloves 6.2 h/day over 9.4 months; disposable gowns 6.2 h/day over 8.8 months. Hu, 2020 N95 mask use resulted in adverse skin reactions in 58 participants (95.1%), including nasal bridge scarring (68.9%), facial itching (27.9%), skin damage (26.2%), dry skin (24.6%), and rash (16.4%). Latex gloves caused reactions in 54 (88.5%) and protective clothing in 37 (60.7%). Skin reactions developed after wearing N95 masks 12 h/day over an average of 3.5 months. Jiang, 2020 Device-related pressure injuries (DRPI), moisture-associated skin damage (MASD), and skin tears (ST). Overall prevalence 42.8% (95% CI 41.30–44.30); DRPI 30.0%, MASD 10.8%, ST 2.0%. Skin injuries were associated with sweating, male sex, grade-3 PPE, and daily wearing time >4 h. Mean daily PPE wear time 7.7 ± 2.9 h. Pei, 2020 Erythema, prurigo, blisters, rhagades, papule/oedema, exudation/crust, and lichenification. Among 484 participants, 73.1% suffered from various skin lesions, including erythema (38.8%), prurigo (22.9%), blisters (13.8%), rhagades (13.6%), papule/oedema (12.8%), exudation/crust (6.8%), and lichenification (5.6%). Lesions were located on the face (47.1%), hands (27.5%), limbs (15.7%), truncus (12.6%), and whole body (2.3%). Medical staff with level 2 and 3	

					protection were more likely to experience itching than those using primary protection (P = 0.0121). More advanced protection (P = 0.0016), higher working frequency (P < 0.001), and longer wearing times of protective suits (P = 0.0016) were associated with facial skin lesions (P = 0.0006). More than half of participants wore the protective suit for 4–6 h at a time, and 9.1% kept it on for >6 h. **Nasal and respiratory symptoms** Houghton, 2020 Difficulty breathing, suffocation, exhaustion and fatigue, sweating, dizziness, dehydration and irritation, backache, and fogging of glasses. Gupta, Singh & Gupta, 2020 Suffocation and heavy breathing (55%) Lee, 2020 New-onset rhinitis symptoms (sneezing, itching, nasal blockage, watery discharge) after wearing FFP respirators for ≥2 hours, with endoscopic signs of irritation and mucosal swelling. Farronato, 2020 Breathing difficulties were at least moderate in 63.5% of the sample but were not correlated with the hours spent wearing N95/FFP2 respirators. These symptoms contributed to moderate impaired working ability in 85.5% of participants. Impaired working ability was strongly correlated with headaches (ρ = 0.212, p < 0.01), breathing difficulties (ρ = 0.566, p < 0.01), concentration problems (ρ = 0.748, p < 0.01), and exertion (ρ = 0.620, p < 0.01). **Ocular symptoms** Giannaccare, 2020 Ocular discomfort symptoms appeared or worsened in 11 subjects (10.3%); 21 (19.6%) reported the need for daily tear substitutes. The mean Ocular Surface Disease Index score was 21, and 61 participants (57%) had pathological values (≥15).	

					Discomfort Chou, 2020 Discomfort, breathing difficulties, and skin events were reported with PPE use; evidence regarding differences between N95 and surgical masks was mixed. Ciris Yildiz, Ulasli Kaban & Tanriverdi, 2020 Pain in the face, redness, sores around the eyes, ears, and nose, and dryness in the throat associated with dehydration. Corley, Hammond & Fraser, 2009 Dehydration associated with headache and skin peeling around the nares. Farronato, 2020 Headaches, breathing difficulties, concentration problems, and exertion associated with FFP2/N95 respirator use. Breathing difficulties were at least moderate in 63.5% of the sample but were not correlated with the hours spent wearing N95/FFP2 respirators. These symptoms contributed to moderate impaired working ability in 85.5% of participants. Impaired working ability was strongly correlated with headaches ($\rho = 0.212$, $p < 0.01$), breathing difficulties ($\rho = 0.566$, $p < 0.01$), concentration problems ($\rho = 0.748$, $p < 0.01$), and exertion ($\rho = 0.620$, $p < 0.01$). Headaches were reported as one of the main outcomes related to FFP2 respirator wear. Gupta, Singh & Gupta, 2020 Suffocation and heavy breathing (55%), excessive sweating (49%), reduced speech quality (44%), skin marks and scarring (43%), friction-related pain and redness (40%), ear discomfort (19%), furunculosis (16%), eye irritation and claustrophobia (14%), and embarrassment (4%). Galehdar, 2020 Wearing protective clothing was described as physically unpleasant for nurses and associated with restrictions in mobility, eating and drinking, changes in mood, fatigue, and altered body image due to concealed identity.	

					Houghton, 2020 Difficulty breathing, suffocation, exhaustion and fatigue, sweating, dizziness, dehydration and irritation, backache, and fogging of glasses. Kang, 2018 Sweating, difficulty breathing, and dizziness reported during PPE use; nurses limited time in isolation rooms to ≤2 hours when wearing PAPR. Lee, 2020 Thermal stress symptoms including thirst (n=144; 87%), excessive sweating (n=145; 88%), exhaustion (n=128; 78%), and desire to move to comfort zones (n=136; 84%). Parush, 2020 High agreement that PPE caused discomfort: 78% (539/688) in Israel and 87% (328/377) in Portugal reported high discomfort. PPE use impaired hearing, speech comprehension, situational awareness, thinking clearly, and decision-making. Purushothaman, 2020 Nasal discomfort (48.8%), dry nose (30.3%), burning sensation (26.1%), itchy nose (~52%), acne (56%), facial redness (39%), sweating around the mouth (67.6%), pain on the nose (30%), ear pain (45.2%), and breathing difficulty during exertion (58.2%). Tabah, 2020 Adverse effects were reported by 80% of respondents, including heat (1266; 51%), thirst (1174; 47%), pressure areas (1088; 44%), headaches (696; 28%), inability to use the bathroom (661; 27%), and extreme exhaustion (492; 20%). Most participants used FFP2/N95 masks (58%), waterproof gowns (67%), and face shields (62%). The median PPE shift without breaks was 4 h (IQR 2–5), and longer PPE shifts were associated with increased adverse events. Tan, 2006	

					Participants reported physical discomfort during prolonged N95 use, including breathing difficulty, headaches, and allergic facial rash around the mask. **Cognitive and psychological effects** Galehdar, 2020 Wearing protective clothing was described as physically unpleasant for nurses and associated with restrictions in mobility, eating and drinking, changes in mood, fatigue, and altered body image due to concealed identity. Gupta, Singh & Gupta, 2020 Claustrophobia (14%), and embarrassment (4%). Parush, 2020 Increased discomfort with PPE was associated with difficulties in hearing, speech comprehension, and situational awareness. High agreement across professions that PPE was uncomfortable: 78% (539/688) in Israel and 87% (328/377) in Portugal. Difficulties reported included seeing surroundings (89% Israel; 84% Portugal), doffing PPE (77% vs 44%, P <.001), hearing (64% vs 50%, P < 0.001), understanding speech (65% vs 47%, P < .001), understanding situations (69% vs 54%, P < .001), thinking clearly (57% vs 43%, P < .001), and decision-making (50% vs 39%, P < .001). Farronato, 2020 Headaches, breathing difficulties, concentration problems, and exertion associated with FFP2/N95 respirator use. Breathing difficulties were at least moderate in 63.5% of the sample but were not correlated with the hours spent wearing N95/FFP2 respirators. These symptoms contributed to moderate impaired working ability in 85.5% of participants. Impaired working ability was strongly correlated with headaches ($\rho = 0.212$, $p < 0.01$), breathing difficulties ($\rho = 0.566$, $p < 0.01$), concentration problems ($\rho = 0.748$, $p < 0.01$), and exertion ($\rho = 0.620$, $p < 0.01$). Headaches were reported as one of the main outcomes related to FFP2 respirator wear.	

Alberta Health Services 2021 Canada Rapid Review	29/06/2021 This review is intended to supplement a previous SAG report that examined the evidence for PPE guidance and changes in acute and long-term care.	27 / 6 USA, Korea, Switzerland, Germany, Italy, UK, Netherlands, Canada, Luxembourg, Australia	HCWs N = NR NR Context: NR	N95 respirators Surgical mask	**Adverse events in general** Alberta Health Services, 2020. Headache, adverse skin reactions, breathing difficulties, rhinitis and nasal symptoms, eye and ear discomfort, and thermal stress were reported. Overall, more severe physical effects (such as headaches, breathing problems, and impaired cognition) were associated with N95 respirators, while more minor effects (such as ear discomfort and skin reactions) were associated with procedural masks. Khalid, 2021. Headache, adverse skin reactions, breathing difficulties, rhinitis and nasal symptoms, eye and ear discomfort, and thermal stress were reported, as well as dizziness, blurred vision, irritability, and memory loss. Gelardi, 2020. Headache, adverse skin reactions, breathing difficulties, rhinitis and nasal symptoms, eye and ear discomfort, and thermal stress were reported, in addition to dizziness, blurred vision, irritability, and memory loss. Burns, 2021. Headache, adverse skin reactions, breathing difficulties, rhinitis and nasal symptoms, eye and ear discomfort, and thermal stress were reported. Unoki, 2020. Headache, adverse skin reactions, breathing difficulties, rhinitis and nasal symptoms, eye and ear discomfort, and thermal stress were reported.	Critically Low

Arikpo, 2025 Nigeria Qualitative evidence synthesis	05/09/2022 This review aimed to (1) synthesize available qualitative research exploring the perceptions and experiences of health and care workers on the use of PPE and physical distancing interventions in healthcare settings in the context of COVID-19 and (2) identify the contexts and conditions that facilitate or hinder uptake and adherence to these interventions.	19 / 14 India, Iran, Indonesia, China, Turkey, Australia, Finland, Portugal, Italy, Spain, UK, US, Belgium, France, Luxembourg, S Korea, Ireland	Health and care workers involved in patient care and those not involved in patient care. Healthcare policymakers. Health facility clients (including residents of care homes, recipients of care – inpatients, and outpatients) and visitors. Community members – general public and members of households. N (633) Health facilities and care home Context: Covid-19	Physical barriers and distancing for infection prevention, including PPEs (e.g., face masks, coveralls, gowns, shoe covers, N95 respirators, gloves, goggles, face shields) Physical distancing (e.g., keeping a distance of a least 1 m or 2 m between patients or persons) Engineering controls (air cleaning and purifier technologies; spatial separation using physical barriers).	**Discomfort** Broom, 2022. Health workers reported physical discomfort when wearing masks and PPE, including difficulty breathing, headaches, a burning sensation in the lungs, abrasion behind the ears from mask straps, and fogging of eyeglasses. Wearing N95 respirators for long shifts was also described as tiring due to the sensation of re-breathing. Fan, 2020. Health workers reported experiencing physical discomfort when wearing masks and PPE. Sivaraman, 2022. Health workers reported experiencing physical discomfort when wearing masks and PPE. Sharma, 2022. Health workers reported experiencing physical discomfort when wearing masks and PPE. Setiawan, 2021. Health workers reported experiencing physical discomfort when wearing masks and PPE. Venesoja, 2021. Health workers reported physical discomfort when wearing masks and PPE, including headaches, a burning sensation in the lungs, abrasion behind the ears from mask straps, and fogging of eyeglasses during long workdays. Ribeiro, 2021. Health workers reported physical discomfort when wearing masks and PPE. Despite these challenges, some workers described that prior familiarity with PPE facilitated adaptation during the COVID-19 pandemic, and several reported gradually adapting to mask use over time. Hayirli, 2021. Health workers reported experiencing physical discomfort when wearing masks and PPE.	Critically Low

					Hoernke, 2021. Health workers reported experiencing physical discomfort when wearing masks and PPE.	

Bakhit, 2021 Australia Systematic review and meta-analysis	18/05/2020 Anecdotal evidence, and some studies, suggest that there may be a variety of downsides arising from mask use, including discomfort, sense of difficulty breathing, and communication problems particularly for those who use lip reading. The aim is to systematically identify and summarize these downsides, to assist policymakers when formulating mask-wearing policies in public settings. They authors also discuss potential strategies to mitigate downsides of mask-wearing.	37 / 10 USA, Australia, Canada, France, China, Hong Kong, Singapore, Japan, Taiwan, Vietnam, Thailand, Germany	People of any age or gender, in any setting N (8547)	Surgical masks, N95 masks, cloth masks (both homemade and commercially available).	**Discomfort and irritation** Discomfort and irritation were reported in five studies (Baig, 2010; Bryce, 2008; Kao, 2004; Lim, 2006; Radonovich, 2009). In a trial of HCWs comparing surgical and N95 masks to prevent influenza, more workers found the N95 uncomfortable (42%) than the medical mask (10%) when worn an average of 5 hours per day, with significant differences in headaches, difficulty breathing and pressure on the nose. A trial of cloth versus medical masks in HCWs found similar rates of discomfort. A cross- over field trial of 27 HCWs found increased discomfort over time; half the subjects were unwilling to wear a medical mask for the full 8-hour shift despite regularly wearing them for short periods. MacIntyre, 2011. Difficulty breathing, Facial irritation or discomfort, Headache. N95= 949 Difficulty breathing (19%), Facial irritation or discomfort (52%), Headache (13%). Surgical Mask= 492 Difficulty breathing (12%), Facial irritation or discomfort (11%), Headache (4%) **Psychological impacts** Nickell, 2004 The observational study reported on the loneliness outcome. In a survey investigating the psychosocial effects associated with working in a hospital during the SARS outbreak, 222 (13%) respondents reported a sense of isolation as one reason masks were perceived as bothersome.	Low

Balestracci, 2023 Italy Systematic review	11/05/2020 To synthesize evidence concerning the range of filtering respirators suitable for patient care and guide the selection and use of different respirator types	39/13 NR	Health care workers N (2657) NR	Respirators Use of disposable respirators Use of reusable respirators Selection and implementation of different respirator types Existing respirator standards	**Skin damages** Han, 2021. Changes in skin parameters were observed after wearing respiratory protective equipment (RPE) for 4–8 hours. In areas covered by RPE, skin hydration, temperature, trans epidermal water loss (TEWL), erythema, and pH increased, whereas in uncovered areas skin hydration decreased and TEWL, erythema, and pH showed minimal changes over time. **Headaches** Lim, 2006. Face-mask–associated headaches were reported by 37.3% of participants. Among them, 32.9% experienced headaches more than six times per month, 7.6% took sick leave (mean of 2 days), 59.5% required abortive analgesics, and 2.1% required preventive medications. Pre-existing headaches and continuous mask use for more than 4 hours were associated with the development of headaches. Ong, 2020. Most HCWs developed de novo PPE-associated headaches or experienced exacerbation of pre-existing headache disorders when using N95 respirators. Ramirez-Moreno, 2020. 51.6% of participants reported de novo headaches. Differences in headache intensity and impact were observed according to the type of mask used, with filter masks associated with worse headache impact. **Discomfort** Honarbakhsh, 2017. Participants reported heat around the face and difficulty breathing associated with respirator use. Or, 2018. Use of N95 respirators was associated with tightness from the respirators and discomfort on the earlobes. **Multiple symptoms**	Critically Low

					Ípek, 2021. Multiple symptoms associated with mask use were reported. For N95 masks, 59% reported headache, 27% palpitations, 80% respiratory distress, 47% dizziness or drowsiness, 11% nausea, 53% facial sweating, 59% suffocation, 50% attention deficit, 62% concentration problems, 62% fatigue, and 9% a feeling of death. For surgical masks, 15% reported headache, 24% respiratory distress, 6% dizziness or drowsiness, 27% facial sweating, 6% suffocation, 15% attention deficit, 18% concentration problems, 15% fatigue, and 3% a feeling of death. Mask use duration was 1–4 hours for N95 masks (one day) and 1–4 hours for surgical masks (next day), with symptoms reported as more severe with N95 masks. Aggregative Published evidence suggests that mask-related safety issues included the following: 1) Increased breathing resistance with subsequent increased respiratory effort; 2) Decreased FiO2 and increased FiCO2; 3) Inconvenience in the face, head, and neck areas, increased humidity, temperature, pressure on the nose, around the ear lobes; 4) Psychosocial effects.	
Burton, 2021 UK Rapid review	11/05/2020 To synthesize evidence concerning the range of filtering respirators suitable for patient care and guide the selection and use of different respirator types	39/13 NR	Health care workers N (2657) NR	Respirators Use of disposable respirators Use of reusable respirators Selection and implementation of different respirator types Existing respirator standards	**Headache** Lim,2006 Headaches associated with mask use were reported. Respirator-related headaches occurred in 37% of participants with prior headache disorders and in 21% of those without prior headache disorders, most commonly tension-type headaches. Continuous mask use for more than 4 hours was reported as a risk factor for headache development. Ong, 2020 128 out of 158 participants reported de novo headaches associated with mask use. Among those affected, 92/128 reported the headaches were always mild, 88/128 did not require analgesics, and most participants experienced only 1–4 headache episodes per month.	Critically Low

					Discomfort Baig, 2010 Approximately 50%–60% of participants reported that masks were uncomfortable, obstructed vision, and interfered with patient care. Brosseau, 2015 Around 10%–20% of participants reported that masks interfered with breathing or with the use of spectacles. Self-reported discomfort reported by ~30% for each type except less heat discomfort with PAPR. Aggregative Three surveys with more than 100 respondents reporting a range of effects on comfort and usability from FFRs in between 10% and 60% of users. Two studies particularly focused on headache associated with FFR use. The first study (N=212) found headaches reported with FFR use in 37% of HCWs with a history of one or more headache disorder and 21% of HCWs without prior headache.	
CDC, 2023 USA Systematic Review and Metanalysis	03/08/2023 HICPAC's Isolation Guideline Update Workgroup requested CDC conduct a systematic literature review to answer the question: for healthcare personnel caring for patients with respiratory infections, what is the effectiveness of medical/surgical masks compared with N95 respirators in preventing infection?	40/27 Indonesia, France, Canada, Thailand, The United States, Switzerland, India, Pakistan, Israel, Egypt, China, Greece, Italy	Healthcare personnel N (NR) They are mentioned emergency departments and respiratory wards of included hospitals, medical units, and pediatric units of eight tertiary care hospitals,	N95 respirators and face protection with similar levels of protection (e.g., FFP2/FFP3	**Headaches** MacIntyre, 2011 It was reported that N95 respirators: 94/701 (13.4%) presented with headache and medical mask: 11/281 (3.9%) presented with headache with $p < 0.01$. Aggregative 10 studies MacIntyre, 2011; Cigiloglu, 2022; Gelardi, 2020; Hajjij, 2020; İpek, 2021; Manerkar, 2021; Peres, 2022; Ramirez-Moreno, 2020; Rapisarda, 2021; Su, 2021; Abdi, 2022; Altun, 2022; Maniaci, 2021; Tatti, 2022) Evidence from 10 studies (N=5,926) suggests headaches are generally more frequent among N95 users compared with surgical mask users, with 7 studies (N=5,272) supporting this association. However, two studies (N=499) found no association, and one study (N=155) reported higher headache frequency in surgical mask users (de novo headache: 31.8% N95 vs. 57.1% surgical; aggravated headache: 28.4% vs. 42.9%).	Low

			outpatient medical centers, including primary care facilities, dental clinics, adult and pediatric clinics,		Loeb, 2022 Headache was reported in 20/434 N95 respirators (4.6%) and in 29/435 surgical masks (6.7%). **Skin problems** MacIntyre, 2011 This study found the following: Skin rash: N95 respirators: 35/701 (5.0%) and medical masks: 13/281 (4.6%) with p = 0.81. Allergies: N95 respirators: 50/701 (7.1%) and medical masks: 26/281 (9.3%) with p = 0.26. Nose pressure: N95 respirators: 366/701 (52.2%) and medical masks: 31/281 (11.0%) with p < 0.01. Aggregative 5 studies (Alizadeh, 2022, Ansari, 2022 ,Bharatha, 2022 ,Liu, 2022 ,Park, 2021) Evidence from five cross-sectional studies (N=2,036) indicates that skin barrier damage is more frequent among N95 users compared with surgical mask users. Two studies (N=407) reported increased odds of lesions with N95 use, while three additional studies (N=1,629) also found higher frequencies of skin damage among N95 users. Aggregative 5 studies (MacIntyre, 2011; Ansari, 2022; Gelardi, 2020; İpek, 2021; Peres, 2022) Evidence from five studies (N=5,026) on itching and rashes is mixed. Four studies (N=1,974) found no difference between N95 and surgical mask users, while one large cross-sectional study (N=3,052) reported higher frequency with N95 use (37.5% vs. 19.4%, p<0.001). Loeb, 2022 Skin irritation was found in 22/434 (5.1%) of those who used N95 respirators and in 25/435 (5.8%) of medical mask users. Radonovich, 2019 Nineteen participants reported skin irritation or worsening acne during years 3 and 4 at one study site in the N95	

					respirator group. **Discomfort** MacIntyre, 2011 Discomfort was reported in 395/943 (41.9%) N95 respirator users and in 48/491 (9.8%) medical mask users ($p < 0.01$). Patient felt uncomfortable was reported in 17/943 (1.8%) N95 respirator users and in 1/491 (0.2%) medical mask users. Loeb, 2022 Discomfort was reported in 20/434 (4.6%) participants using N95 respirators and in 42/435 (9.7%) using medical masks. MacIntyre, 2013 Comfort (no problems reported) In N95 respirator: 217/574 (38%) In Targeted N95 respirator: 317/512 (62%) In Medical mask: 297/571 (52%) With $p < 0.001$. **Difficulty breathing** MacIntyre, 2011 Difficult breathing was reported in 136/701 (19.4%) in N95 respirators and in 35/281 (12.5%) in medical masks with $p = 0.01$. Aggregative 6 studies (MacIntyre, 2011; İpek, 2021; Liu, 2022; Nwosu, 2021; Peres, 2022; Su, 2021) Evidence from six studies (N=5,761) consistently indicates that difficulty breathing is more frequent among N95 users compared with surgical mask users. All studies reported increased shortness of breath or labored breathing with N95 use, including two RCTs, one quasi-experimental study and three cross-sectional studies. **Dizziness** Aggregative 3 studies (Gelardi, 2020; İpek, 2021; Su, 2021) Evidence from three studies (N=218) suggests dizziness is more frequent among N95 users compared with surgical mask users. An RCT (N=68) reported dizziness in 14.7% of	

					N95 users vs. 0% of surgical mask users (p=0.027) ; a quasi-experimental study (N=34) reported 23.8% vs. 5.9% (p=0.70) ; and one cross-sectional study (N=116) found higher mean dizziness scores with N95 (0.7±2.1 vs. 0.1±0.9, p=0.02). Findings were reported with eight or more hours of PPE use. **Pain** Aggregative 3 studies (Ansari, 2022; Gelardi, 2020; Liu, 2022) Evidence from three studies (N=1,589) overall suggests no clear difference in pain between N95 and surgical mask users. Two cross-sectional studies (N=1,473) found no difference in facial or ear pain (face pain: 34.6% vs. 37.5%, p=0.503; indentation/ear pain: 52.6% vs. 51.9%, p=0.885. However, one smaller study (N=116) reported higher facial pain scores among N95 users after ≥8 hours (2.9±2.8 vs. 1.6±2.8, p=0.007). **Fatigue** Aggregative 3 studies (Cigiloglu, 2022; İpek, 2021; Su, 2021) Evidence from three studies (N=413) suggests fatigue is more frequent among N95 users compared with surgical mask users. An RCT (N=68) reported fatigue in 26.5% of N95 users vs. 0% of surgical mask users after 8 hours (p=0.001); a quasi-experimental study (N=34) found higher fatigue (61.8% vs. 17.6%, p<0.001) and drowsiness (47.1% vs. 5.9%, p=0.001) with N95 use ; and one cross-sectional study (N=311) reported higher mean fatigue scores with N95 (8.59±5.48 vs. 6.04±4.41, p<0.001). **Heart rate** Aggregative 3 studies (Alroudhan, 2021; Manerkar, 2021; Su, 2021) Three studies (N=51, 128, and 68) assessed heart rate changes: one (N=51) found a significant increase with N95 use after 1–3 hours, another (N=128) reported no differences between N95 and surgical masks, and one RCT (N=68) observed a slight decrease after 8 hours; overall, cardiovascular adverse events were inconsistent and	

					remained within normal ranges. **SpO2** Aggregative 4 studies (Iroudhan, 2021, Manerkar, 2021, Nwosu, 2021, Su, 2021) The evidence from four studies (N = 323) is inconclusive on changes in SpO2 between HCP who wear N95s and those who wear masks, but levels remained within normal ranges (95-100%) among HCP wearing N95s and HCP wearing surgical masks.	
Çakar, 2025 Türkiye Systematic review	19/08/2022 The aim of the systematic review study is to determine the skin problems and related factors due to the use of PPE.	15 / 15 Singapore, China, Türkiye, England, Italy, Canada, India, Ireland	HCWs N = 8829 NR Context: Covid-19	N95 respirator FFP3 respirator Surgical mask Goggles Face shield Silicone mask Level 2 PPE Level 3 PPE	**Skin problems** Foo, 2006 Acne (59.6%), irritation (51.4%), rash (35.8%). Anatomical regions most frequently affected: nasal bridge, cheeks, and chin. Overall rate of skin problems: 35.5%. Associated with N95 mask use. Wearing time: N95 mask = 8 h. Xia, 2020 Pressure injury (58.24%). Most affected anatomical regions: nasal bridge (81.0%), cheeks (66.5%), forehead (45.1%), and back of ears (43.6%). Overall rate of skin problems: 80.0%. Wearing time: 4–6 h (48.2%), 6–8 h (28.0%). Abiakam, 2021 Stage 1: Rash (70.0%), pressure injury (39.0%), irritation (39.0%), eruption (17.0%), dryness (9.0%). Most affected regions: nasal bridge, ears, cheeks, and chin. Stage 2: Rash (35.0%), pressure damage (27.0%), irritation (22.0%), dryness (13.0%). Most affected regions: nasal bridge (27.0%), cheeks (29.0%), forehead (10.0%), chin (18.0%), ears (28.4%). Rate of skin problems: Stage 2 = 88.0%. Wearing time: Stage 1 = 9.2 ± 2.6 h; Stage 2 = 6–8 h (31.0%), 10–12 h (26.0%). Hu, 2020 Mark formation on nasal bridge (68.90%), irritation (27.90%),	Critically Low

					skin damage (26.20%), dry skin (24.60%), eruption (16.40%), acne (1.60%). Rate of skin problems: 95.10%. Associated with N95 mask use. Wearing time: 12 h. Atay and Cura, 2020 Sweating and rash on cheeks, nasal bridge, ears, and around eyes. Due to N95 mask: sweating (64.20%), cheeks (64.20%), nasal bridge (53.0%), ears (47.40%). Due to surgical mask: sweating (50.9%), cheeks (41.20%), nasal bridge (38.30%), ears (46.40%). Due to goggles/face shield: sweating (47.60%), rash around eyes (27.10%). Jiang 2020 Device-related pressure injury (30.3%) and sweating (34.07%). Most affected regions: nasal bridge (24.43%), cheeks (23.46%), around ears (20.32%), forehead (10.98%). Overall rate of skin problems: 30.03%. Wearing time: 7.67 ± 2.92 h. Burns, 2021 Rash, dryness, and blemishes, most frequently on the nose, cheeks, and ears. Due to FFP3 mask: rash (33.0%), dryness (25%), blemishes (22.0%). Due to surgical mask: blemishes (14.0%), dryness (13.0%), rash (12.0%). Bambi, 2021 Device-related pressure injury (77.1%), irritation (15.8%), erythema (9.8%), sweating (7.5%). Most affected regions: nasal bridge (87.3%), ears (38.0%), forehead (33.2%), cheeks (12.2%). Skin problem rate: 77.1% (DRPI). Moore, 2021 Abrasion (16.0%) and skin tears (9.0%). Anatomical regions not reported. Overall rate of skin problems: 29.0%. Duan, 2021 Device-related pressure injury (13.0%), acne (10.0%),	

					allergic dermatitis (4.0%). Overall skin problem rate: 97.0%. Wearing time: 5.00 ± 1.71 h. Yuan, 2021 Rash (72.8%), burning pain (60.4%), dermatitis (9.6%), irritation (29.3%), mark formation (63.8%), blister (16.3%). Most affected regions: nasal bridge (54.2%), cheeks (52.8%), forehead (25.9%), ears (21.7%). Wearing time: 6 ± 1.45 h. Yıldız, 2021 Stage 1 pressure injury (29.2%), erythema (27.1%), papule and pustule lesions (12.5%), irritation (18.8%). Most affected regions: nasal bridge (43.8%), cheeks (35.4%), forehead (10.4%), chin (6.3%). Skin problem rate: 47.9%. Wearing time: 3.79 ± 1.18 h. Jiang 2021 Device-related pressure injury (56.5%), moisture-associated skin damage (19.4%), skin tears (3.5%), sweating (80.0%). Most affected regions: nasal bridge (5.2%), cheeks (3.4%), ears (1.9%), forehead (0.6%). Skin problem rate: 79.5%. Wearing time: 6.9 ± 2.2 h. Kısacık and Özyürek, 2022 Sweating and moisture, mark formation, skin lesions, irritation, erythema, and disruption of skin integrity. Due to surgical/N95 mask: nasal bridge (69.4%), ears (69.8%), chin (38.4%), cheeks (36.8%) Due to goggles/face shield: forehead (67.8%), nasal bridge (63.5%), around eyes (54.1%), ears (31.5%). Event frequencies: surgical/N95 mask—sweating/moisture (73.6%), mark formation (53.9%), skin lesions (52.8%), irritation (38.0%), erythema (34.8%), disruption (11.3%); goggles/face shield—sweating/moisture (48.2%), mark formation (38.3%), irritation (18%), erythema (7.7%), disruption (4.1%). Wearing time: >4 h (67.0%), ≤4 h (33.0%). Kaur,2022 Erosions, pressure injury, sweating/moisture, rash, and acne. Most affected regions: nasal bridge (79.9%), ears (55.0%).	

					Skin problems rate: N95 mask (96.0%), goggles (92.0%). Due to N95 mask: erosions (80.0%), pressure injury (79.5%), sweating/moisture (74.0%), rash (60.0%), acne (47.0%). Due to goggles: sweating/moisture (51.0%), pressure injury (4.5%). Wearing time: 6.3 ± 1.29 h (daily average).	
Fakherpour, 2023 Iran Systematic review	21/03/2023 The authors systematically reviewed the studies performed on respirator fitting and affective factors during COVID-19	137 / 9 The United States, Australia, United Kingdom, Canada, China, Iran, Japan, South Korea, Italy, India, Germany, Spain, Brazil, the Netherlands, Singapore, Turkey, Saudi Arabia, France, Malaysia, Pakistan, and Switzerland	HCWs N = 2,888 NR	N95 respirators FFP2 KN95 NIOSH	**Discomfort** Cloet, 2022 MNmask v2 showed higher usability scores than MNmask v1 (including lower subjective discomfort and better breathability and speech intelligibility), although it had lower stability due to the paracord bands. Cloet, 2022 Sources of discomfort included nose wire pressure (nose discomfort), foam pressure on chin and cheekbones, band-related discomfort on head and neck, and filter material–related skin discomfort such as rash, skin indentations, and itching. Suen, 2022 Compared with traditional 3M FFRs, the nanofiber FFR showed better usability and lower discomfort across several dimensions, including facial heat, breathability, facial pressure, itchiness, difficulty maintaining the mask in place, ear lobe discomfort, and overall comfort level ($p < 0.001$).	Critically Low
Farah, 2024 United States Systematic review and evidence map	28/07/2023 This systematic review synthesizes the evidence on the acute physiological, cognitive and psychological impacts associated with different types of masks and provides an evidence map of research gaps.	19 / 1 NR	General population (including HCW) N= 12 NR Context: NR	FFP2	**Respiratory and perceived exertion outcomes** Pimenta, 2021 Compared with no mask, the use of FFP2 respirators was associated with greater perceived exertion (RPE) and increased dyspnea, indicating higher subjective breathing effort during mask use. **Physiological outcomes** Pimenta, 2021 Mask use was associated with reductions in oxygen saturation (SpO_2). The mean difference for surgical masks compared with no mask was −2.00 (−4.68, 0.68), while for FFP2/N95 respirators it was −3.20 (−5.93, −0.47). Heart rate showed no meaningful change with FFP2/N95 compared with no mask (mean difference 0.70; −10.58, 11.98)	Low

					Psychological outcomes Pimenta, 2021 Small increases in psychological burden were observed with mask use. The mean difference compared with no mask was 0.51 (−0.30, 1.33) for surgical masks and 0.84 (−0.01, 1.68) for FFP2/N95 respirators.	
Farronato, 2020 Italy Scoping review	31/05/2020 To assess the perceived experience associated with N95/FFP2 respirators based on the available literature and data collected through an online survey completed by Italian dental professionals.	5 / 5 China, Singapore	HCWs N = 555 NR Context: Covid-19, SARS	N95 FFP2 respirator medical mask Respirator not specified	**Headaches** Ong, 2020 In a sample of 158 HCWs, 128 (81%) reported bilateral headaches associated with respirator use. Most respondents (81.3%) developed headaches within 60 minutes of donning an N95 respirator, and symptoms resolved within 30 minutes in 88.3% of participants. Prolonged use (>4 h/day) was identified as a risk factor, with 132 (83.5%) using respirators for 1–4 h/day and 26 (16.5%) for more than 4 h/day. Potential mechanisms included pressure and traction from mask straps, hypercapnia, hypoxemia, and workload-related stress. Additionally, 82.8% of participants with de novo headaches reported a slight decrease in work performance. Lim, 2006 79 HCWs (37.3%) reported headaches associated with respirator use. Among these, 62.7% had no previous history of headaches and developed them while wearing an N95/FFP2 respirator. Duration of use was identified as a risk factor: 110 (51.9%) wore respirators for <4 h/day and 102 (48.1%) for >4 h/day, with prolonged use (>4 h/day) associated with headache development. Chughtai, 2019 Reported adverse effects included headaches in 9 (6.1%). **Breathing difficulties** Rebmann, 2013 Participants reported breathing difficulties (22.1%)	Critically low

					associated with respirator use during 12-hour shifts with doffing periods. Chughtai, 2019 Reported adverse effects included breathing difficulties in 18 participants (12.2%), **Discomfort** Shenal, 2011 Among 27 HCWs, discomfort and exertion increased over time during respirator use, even when 8-hour shifts included doffing periods every 2 hours. Rebmann, 2013 Participants reported breathing difficulties (22.1%) and discomfort (22.1%) associated with respirator use during 12-hour shifts with doffing periods. Some HCWs reported removing respirators briefly due to discomfort. The study also measured physiological parameters and found a statistically significant increase in CO_2 levels compared with baseline, although this increase was not clinically relevant, and no changes in O_2 levels were observed. Chughtai, 2019 Reported adverse effects included breathing difficulties in 18 participants (12.2%), headache in 9 (6.1%), pressure on the face in 25 (16.8%), and discomfort in 14 (9.5%) among 148 HCWs. Reported daily mask use duration was 1–2 h/day: 1 (0.7%), 3–4 h/day: 8 (5.4%), 5–6 h/day: 40 (27%), 7–8 h/day: 80 (54.1%), and >8 h/day: 19 (12.8%). The study found 12.2% breathing difficulties, which was lower than estimates in other samples, possibly due to differences in the type of mask used (surgical masks rather than N95/FFP2 respirators).	

Franco, 2021 Brazil Scoping review	12/06/20 To map the use of PPE by healthcare professionals to combat COVID-19 in healthcare settings.	13 / 11 90 different countries across Africa, Asia, Europe, North America, Oceania, and South America.	HCWs N = 142,870 ICU; Hospitals and clinics (includes home care clinics, community pharmacies and health districts); Isolation wards; Emergency rooms; Frontline; Pre-hospital and hospital care; Inpatient and outpatient. Context: Covid-19	FFP2/N95 mask FFP3 (or equivalent standard) Surgical mask Face shields/goggles Breathing certified masks PPE (including masks)	**Adverse effects in general** Parush, 2020 Most respondents reported adverse effects to the use of PPE **Headaches** Ong, 2020 Face shield, N95 mask, and goggles. Participating professionals reported headaches associated with PPE, especially when using the N95 mask. **Discomfort** Ong, 2020 N95: Discomfort in the correspondent contact areas of the equipment. **Skin reactions** Hu, 2020 Skin reactions may be associated with the prolonged use of protective equipment. The most common adverse skin reactions included scars on the nasal bridge, facial itching, skin damage, rashes, cracked skin, and papules. **Physical and ergonomic discomfort** Parush, 2020 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.	Critically Low

Gama, 2021 Belgium, Portugal and Netherlands Scoping review	07/2021 The authors aim to detect, analyze, interpret and summarize the potential effects of face masks on voice assessment parameters	9 / 3 NR	Health personnel N = 255 NR Context: NR	N95 respirators Surgical mask	**Vocal and speech effects** McKenna, 2021 Significant increase in perceived vocal effort while wearing a face mask. HNR values increased after a workday with a mask compared to the value prior to the workday. Heider, 2020 Significant increase in perceived vocal effort while wearing a face mask. This can demonstrate that HCWs and all other subjects that work with face masks can be at a higher risk of voice disorder development, making these authors raise the question of whether these subjects should be considered occupational voice users. Nguyen, 2021 It was observed a significant main effect of masks on speech mean spectral values in high-frequency levels (1000–8000 Hz) in one study (p = 0,001), with attenuation of spectral levels for high frequencies calculated as 5.2 dB for KN95 (p = 0,005) and 2.0 dB for surgical mask (p = 0,014). No significant changes in fundamental frequency (F0) values or Cepstral peak prominence (CPP) were observed.	Critically Low
Iannone, 2020 Italy Rapid Review	21/3/2020 They authors conducted a systematic review aimed at assessing the efficacy of N95 respirators versus surgical masks for the prevention of respiratory tract infections transmission among HCWs.	4 / 1 Canada, China, USA	HCWs N = 8,736 Hospitals, emergency departments and respiratory wards Context: NR	Fit-tested N95 respirator Nonfit-tested N95 respirator Surgical mask	**Headaches** MacIntyre, 2011 N95 respirator: 13.4% (94/701) **Difficulty breathing** MacIntyre, 2011 N95 respirator: 19.4% (136/701) and surgical masks: 12.5%(35/281) **Skin problems** MacIntyre, 2011 Pressure on nose: N95 respirator 52.2%(366/701) and surgical masks 11%(31/281) Allergies: surgical masks 9.3%(26/281)	Low

Jefferson, 2023 Canada Systematic review and meta-analysis	04/10/2022 To assess the effectiveness of physical interventions to interrupt or reduce the spread of acute respiratory viruses. We further propose solutions to mitigate this problem.	78 / 4 USA, Japan, China	General population (including HCW)	N95/P2 respirators Medical/ surgical masks	**Skin irritation and acne** Radonovich, 2019 N95: 19 participants reported skin irritation or worsening acne during years 3 and 4 at 1 site. **Discomfort** MacIntyre, 2011 Discomfort: 41.9% in N95 users vs 9.8% in medical-mask users (P < 0.01) MacIntyre. 2013 N95 respirator: reported problems (38% (195/512) Affected site: face (47.1%), hands (27.5%), limbs (15.7%), trunk (12.6%), and whole body (2.3%). PPE (100%): divided into biosafety level 1 (18.2%), level 2 (64.1%), and level 3 (17.2%) Daye, 2020 Symptoms: dryness (76.6%), itching (51.8%), flaking (40.2%), and tingling (29.8%). Affected site: hand surface (60.7%), nose bridge (40.7%), ears (28.4%), and cheeks (25.7%). Masks with metal nose bridge (92.7%), gloves (76.1%), goggles (67.0%), and visors (37.0%) O'Neill, 2021 Dermatosis was determined to be occupational in 315/337 (93.5%). Clinical diagnoses: irritant contact dermatitis (59%), acne or rosacea (17%), atopic eczema (12%), allergic contact dermatitis (7%), and facial pressure injury (3%) Lin, 2019 Symptoms: dryness or scales (68.6%), papules or erythema (60.4%), and maceration (52.9%). Affected site: hands (84.6%), cheeks (75.4%), nasal bridge (71.8%). Yan, 2020 Seventy-one percent of participants reported skin barrier damage. Main symptoms: burning, itch, and stinging. Main types of lesions: dryness or scales, papules, erythema, and maceration. Hand washing >10 times per d (66.1%), PPE	High

					use for >6 h per d (56.7%), and wearing 3 layers of gloves (12.4%). Kiely, 2021 Symptoms: dry skin (75.4%), redness (36.9%), and itching (27.6%). Affected site: hands (76.5%), nose (13.7%), and cheeks (12.6%). Ferguson, 2021 Clinical diagnoses: irritant contact dermatitis (77.5%), suspected allergic contact dermatitis (18.6%), and atopic dermatitis (15.6%). Affected site: hands (77.1%) and face (64.1%). Mushtaq, 2021 Symptoms: pruritus (45.5%), burning (46.5%), and stinging (6.9%). Morphology: erythema (79.2%), papules (60.4%), vesicles (17.8%), and xerosis (15.8%). Affected site: hands (72.3%), face (22.8%), and trunk (6.9%). Most common diagnosis: contact dermatitis (72.3%). Culprit agents (not total prevalence of each): soap and water (56.4%), gloves (47.5%), sanitizer (38.6%), and mask (20.8%) Hu, 2020 Lesions due to N95 masks (58/61): nasal bridge scarring (68.9%), facial itching (27.9%), and skin damage (26.2%). N95 masks (100%), latex gloves (100%), and protective clothing (100%) Aggregative Most commonly affected body sites (total cohort size n=3958): Face: Nose or nose bridge 978 (24.7%), Cheeks 845 (21.3%), Forehead 407 (10.3%), Others or not specified 707 (17.9%). Types of dermatoses (total cohort size n=3958): Xerosis 1094 (27.6%), Erythema 876 (22.1%), Irritant contact dermatitis 587 (14.8%), Maceration 439 (11.1%), Fissures or erosions 436 (11.0%), Vesicles or pustules 205 (5.2%), Allergic contact dermatitis 67 (1.7%), Others or not specified 1700 (43.0%).	

					Commonly implicated occupational contactants or PPE (total cohort size n=3958): N95 masks 1064 (26.9%), PPE use, but not specified 2170 (54.8%).	
Kunstler, 2022 Australia Systematic review and meta-analysis	14/06/2021 To examine the differences in likelihood of SARS-CoV-2 infection and AEs between HCWs using respirators and surgical masks.	21 / 9 USA, South Korea, Turkey, China, Italy, Spain, Pakistan, Switzerland, India, Singapore, Malaysia	Health care workers	FFP2, N95 KN95 KF94 Equivalent respirators Surgical masks	**Headache** Garra, 2021 N95 respirator: Headache 40/72. Surgical mask: Headache 32/72. Participants were required to wear a mask for ≥2 h to be eligible for the study. Mean wear time was >5 h for all participants, with no statistically significant differences between groups (surgical mask = 6.8 h, respirator = 5.7 h). Ramirez-Moreno, 2020 FFP2/N95/KN95 respirator: Headache 39/53. Surgical mask: Headache 119/208. Occurrence of a de novo headache was more likely when using a respirator compared to a surgical mask (OR = 2.14 [95% CI 1.07–4.32]) when controlling for profession and asthma. Mean surgical mask wearing time was greater (7.0 h) than mean respirator wearing time (6.7 h), but this difference was not statistically significant. Ipek, 2021 N95 respirator: Headache 20/34. Surgical mask: Headache 5/34. Respiratory distress or shortness of breath Garra, 2021 N95 respirator: Respiratory distress or shortness of breath 39/72. Surgical mask: Respiratory distress or shortness of breath 29/72. Maniaci, 2021 FFP2 respirator: Respiratory distress or shortness of breath 17/42. Surgical mask: Respiratory distress or shortness of breath 15/111.	Critically Low

					The occurrence of nasal symptoms (p = 0.001) and pulmonary disorders (p = 0.002) were more likely for HCWs wearing respirators compared to surgical masks. The majority (68.9%) of respondents wore masks/respirators for >6 h. Ipek, 2021 N95 respirator: Respiratory distress or shortness of breath 27/34. Surgical mask: Respiratory distress or shortness of breath 8/34. **Skin conditions** Garra, 2021 N95 respirator: Facial itching or irritation 54/72. Surgical mask: Facial itching or irritation 40/72. Ipek, 2021 N95 respirator: facial itching or irritation 9/34. Surgical mask: Facial itching or irritation 8/34. Han, 2021 More erythema was experienced in skin areas covered by respirators compared to surgical masks, albeit not statistically significant. Furthermore, there were no significant differences in skin hydration, sebum secretion, and pH between surgical mask and respirator groups. 70% of surgical mask users wore them for >8 h, compared to 60% of respirator users. There was no statistically significant difference in mask wear time between the groups. Jiang, 2021 The use of N95 respirators and goggles was associated with significantly more skin injuries (device-related pressure injuries, moisture-associated skin damage and skin tears) than surgical masks and goggles (89.5% vs 37.4%, P < 0.001). Montero-Vilchez, 2021 More erythema was present for those wearing surgical masks compared to FFP2 respirators, but this finding was not significant (p = 0.640). Trans epidermal water loss was significantly greater in areas covered by a surgical mask	

					compared to a respirator (p = 0.034). Daily mask wear time was not stated but each respondent needed to wear a mask for >2hr to be included in the study. Zuo, 2020 Use of respirators was associated with a higher incidence of facial skin symptoms compared to using surgical masks (OR = 2.63 [95% CI 1.3–5.4]) when adjusted for sex, allergies, underlying inflammatory facial dermatosis, and frequency and duration of mask use. The majority (56.9%) of respondents wore either a surgical mask or respirator for > 4h. Zaib, 2020 N95 respirator: Facial itching or irritation 3/150. Surgical mask: Facial itching or irritation 3/150. **Pressure-related injury** Garra, 2021 N95 respirator: Pressure-related injury 38/72. Surgical mask: Pressure-related injury 21/72. Han, 2021 Pressure- related injury: N95 sweating 838/1301- Surgical mask: 73/310 Jiang, 2021 N95 respirator: Pressure-related injury 838/1301. Surgical mask: Pressure-related injury 73/310. Zaib, 2020 N95 respirator: Pressure-related injury 2/150. Surgical mask: Pressure-related injury 0/150. **Sweating** Garra, 2021 Ipek, 2021 N95 respirator: sweating 18/34. Surgical mask: sweating 9/34, Han, 2021	

					N95 sweating 1220/1301 Surgical mask sweating 69/310. Jiang, 2021 N95 respirator: Sweating 1220/1301. Surgical mask: Sweating 69/310. Zaib, 2020 N95 respirator: Sweating 25/150. Surgical mask: Sweating 15/150. **Concentration difficulties** Ipek, 2021 N95 respirator: concentration difficulties 17/34. Surgical mask: concentration difficulties 5/34. Maniaci, 2021 FFP2 respirator: Attention deficit or disorders 16/42. Surgical mask: Attention deficit or disorders 35/111.	
Leung, 2022 Australia Scoping review	08/2021 To compile existing evidence on this emerging issue of workplace PPE-related psychological impacts	26 / 13 India, Italy, USA, Singapore, England, Austria, Turkey, Canada, Japan, Spain, Hong Kong, Iran, Other countries	HCWs N = 4,095 NR Context: Not specified	N95 Surgical mask PAPR Face masks in general (type not specified) Masks with valves Face shield mask Face respirators Face shield	**Psychological impact** Benítez, 2020 Perceived PPE-related impacts; communication; cognitive impact. Surgical mask; N95; face shield. Cheok, 2021 Perceived PPE-related impacts; communication. Surgical mask; N95; filtering face piece mask; cloth mask/scarf (not PPE). Choudhury, 2020 Physiological factors (heart rate, oxygen saturation, perfusion index); perceived PPE-related impacts. N95 Hoedl, 2020 Psychological factors (stress). Surgical mask; Filtering face piece mask İpek, 2021 Perceived PPE-related impacts; physiological factors (blood gas); cognitive impact. N95	Critically Low

					Rebmann, 2013 Physiological factors (blood pressure, heart rate, CO2 and O2); Perceived PPE-related impacts. Surgical mask; N956 Thiagarajan, 2021 Psychological factors (fatigue, stress); perceived PPE-related impacts. Surgical mask; N95; face shield mask; face respirators; face shield Aggregative There were seven articles that reported individuals perceived PPE impacts (Benítez et al. 2020; Cheok et al. 2021; Choudhury et al. 2020; İpek et al. 2021; Rebmann et al. 2013; Singh et al. 2021; Thiagarajan et al. 2021). These articles reported on the physical and subjective symptoms associated with wearing PPE. Additionally, there were three articles that assessed the cognitive impact associated with facial PPE with two studies finding that participants experienced a negative effect on their decision-making and felt greater attention deficit and difficulty concentrating (Benítez et al. 2020; İpek et al. 2021). PPE that occluded a part of the face resulted in negative psychological impacts, specifically increasing stress, fatigue, and perceiving someone who wore PPE in a more negative light. Of note, Hoedl et al. (2020) reported no significant association between stress and PPE use in nurses, but nurses who wore masks for more than eight hours had significantly higher levels of stress than those who used masks for shorter periods (p = 0.000).	
Licina, 2020 Australia Systematic review	06/2022 To evaluate the effect of powered air- purifying respirators (PAPRs) as part of respiratory protection versus another device (egN95/FFP2) on HCW infection rates and contamination	10 / 2 NR	HCWs volunteers N = 22 NR Context: not specified	PARP N95	**Discomfort** Chughtai, 2018 -24/24 reported discomfort with N/95 use; -2/6 reported discomfort with PAPR use; In a single cohort observational study, all participants using N95 reported discomfort. In observational studies, we identified a trend towards a greater level of self-reported comfort amongst the PAPR wearers [42, 44] Powell, 2017	Low

					-temperature of facial skin lower in 36 PAPR compared to N95. -tight fitting face piece PAPR increased eye dryness. -loose fitting PAPR did not increase eye dryness. -perception of comfort equivalent in two groups. -perception of work of breathing was equivalent in the two groups. Powell et al. noted a lower temperature measurement in subjects using PAPR. This did not translate to a self-reported greater level of comfort in this study. In line with subjective reports that PAPR may be more effective in decreasing the effort needed to maintain the work of breathing compared to a more conventional filtering facepiece, we identified moderate quality of evidence for this outcome [43]. Powell et al. noted a lower temperature measurement in subjects using PAPR [43]	
Lu, 2023 Canada An umbrella meta-analysis	06/2022 There is a strong rationale for assessing whether a stricter masking policy for HCWs is needed. Specifically, we are interested primarily in whether there is evidence to support a policy of wearing respirators (N95 or equivalent or higher level) instead of medical masks when providing patient care; and secondarily, whether wearing such respiratory protection universally and continuously in the patient care environment should be adopted in light of new variants.	10 / 1 NR	HCWs NR NR Context: Covid-19	N95 respirator or equivalent or higher level medical masks	**Adverse effects in general** Headaches, respiratory distress, facial irritation, and pressure-related injuries Kunstler, 2022 Reported that HCWs who wore respirators over a prolonged period experienced significantly more headaches, respiratory distress, facial irritation, and pressure-related injuries (OR = 4.39, 95% CI = 2.37–8.15, which is the greatest odds ratio among all findings) compared with HCWs who only wore surgical masks.	Critically Low

Montero-Vilchez, 2021 Spain Systematic review and meta-analysis	21/01/2021 The aims of this study were to summarize the prevalence, type and risk factors for cutaneous adverse events related to PPE and to evaluate preventive measures taken to avoid cutaneous adverse events related to PPE in HCWs and the general population.	35 / 6 China, Turkey, Italy, Thailand, Poland, Saudi Arabia. Poland, Spain	General population (including HCW) N = 2714 NR Context: Covid-19	N95 PPE PPE including mask with metal nose bridge PPE including N95/FFP2 mask Surgical mask Cloth mask Surgical masks covered by a piece of cloth Respirators (N95/FFP2) Half-face mask FFP2	**Skin adverse effects** Lan, 2020 Skin side effects were reported in 97% of participants. Symptoms included dryness/tightness, tenderness, itching, and burning or pain, while signs included desquamation, erythema, maceration, fissure, papule, erosion and ulcer, vesicle, and wheal. Wearing an N95 mask or goggles was associated with more skin side events, and PPE wearing periods longer than 6 hours were related to a higher occurrence of skin side effects. Daye, 2020 Skin side effects included dryness, itching, flaking, tingling, spalling, peeling, and lichenification, with a reported prevalence of 90.2%. Battista, 2020 Skin side effects included itching, acne, skin rash, and pressure-related symptoms, with a prevalence of 53.02%. Longer PPE use, particularly with N95/FFP2 masks, increased the risk of skin side events, and wearing PPE for more than 6 hours further increased this risk. Techasatian, 2020 Skin side effects included acne, rashes, itch, pigmentation, and pressure-related skin injuries, with a prevalence of 54.5%. Longer mask-wearing periods (>4 hours) were associated with an increased risk of skin side events. Krajewski, 2020 General skin side effects had a prevalence of 31.6%. The use of N95/FFP2 masks increased the risk of skin side events compared with other masks, and wearing masks for longer periods (>4 hours) further increased the risk. Montero-Vilchez, 2021 Skin side effects related to mask use were associated with skin barrier dysfunction. Compared with no mask, TEWL, temperature, and erythema were higher in the areas covered by masks, while stratum corneum hydration was lower. TEWL was significantly greater in areas covered by a	Critically Low

					surgical mask than those covered by an FFP2 respirator (12.54 vs 5.28 g/h/m², p = 0.026). Aggregative The rate of cutaneous adverse events related to PPE use is very high, and longer use periods were the most important risk factors for developing them. Most skin adverse events were mild, being dryness, pressure-related symptoms and itching the most frequent. Frequent handwashing, gloves and mask use are important agents related to skin disorders. Hydrogel patches could be a protective measure against mask-related symptoms.	
Sahebi, 2022 Iran Systematic review and meta-analysis	01/2022 Investigating the prevalence of headache associated with PPE in HCWs during COVID-19, and the prevalence of headache after using PPE and before using PPE was investigated among the studies conducted in this field.	26 / 25 United Arab Emirates, Singapore, Pakistan, Spain, Spain, Turkey, Iran, Bangladesh, Turkey, India, Australia, UK, Portugal	HCWs N = 8,697,711 NR Context: Covid-19	N95 mask N99 mask FFP2 mask FFP3 mask Surgical mask other mask Face mask Filtering mask (FFR mask) Filtering + surgical mask Half/Full respirator PAPR Face shield / visor Goggles Protective eyewear Eye protective equipment PPE	**Headaches** Hajjij, 2020 Pre-existing headaches were reported in 29% of participants and post-use PPE headaches in 32.9%. Most participants used PPE for more than 4 hours (<4 h: 32.9%; >4 h: 67.1%). Ong, 2020 Pre-existing headaches were reported in 29.1% of participants and post-use PPE headaches in 81%. PPE wearing time was <4 h in 16.46% and >4 h in 83.54% of participants. Zaheer, 2020 Pre-existing headaches were reported in 21.1% of participants and post-use PPE headaches in 28.2%. PPE wearing time was <4 h in 10% and >4 h in 90% of participants. Ramirez-Moreno, 2020 Pre-existing headaches were reported in 41.1% of participants and post-use PPE headaches in 51.6%. Mean PPE wearing time was 6.9 (SD 2.3) hours. Rapisarda, 2020 Pre-existing headaches were reported in 56.65% of participants and post-use PPE headaches in 26.5%. PPE wearing time was <4 h in 6.3% and >4 h in 93.7% of participants.	Critically Low

					Toksoy, 2021 Pre-existing headaches were reported in 30.4% of participants and post-use PPE headaches in 30.9%. PPE wearing time was <4 h in 7.7% and >4 h in 92.3%. Jafari, 2021 Pre-existing headaches were reported in 44.3% of participants and post-use PPE headaches in 77%. PPE use was reported for more than 4 hours. Joy, 2021 Pre-existing headaches were reported in 11.1% of participants and post-use PPE headaches in 59.9%. PPE wearing time was <6 h in 19.5% and >6 h in 80.5%. Çaglar, 2021 Pre-existing headaches were not reported, while post-use PPE headaches were reported in 36.5% of participants. PPE use was reported for more than 4 hours. Jose, 2021 Pre-existing headaches were not reported, while post-use PPE headaches were reported in 73.4% of participants. PPE wearing time was 6 hours. Thiagarajan, 2021 Pre-existing headaches were reported in 11.4% of participants and post-use PPE headaches in 43%. PPE wearing time was <3 h in 31% and >3 h in 62.3%. Hacibeyoglu, 2021 Pre-existing headaches were reported in 31.1% of participants and post-use PPE headaches in 65.5%. PPE wearing time was <4 h in 6.2% and >4 h in 93.8%. Tabah, 2021 Pre-existing headaches were not reported, and post-use PPE headaches were reported in 28%. PPE wearing time	

					was approximately 4 hours. Bansal, 2021. Pre-existing headaches were not reported, and post-use PPE headaches were reported in 44%. PPE wearing time was <4 h in 12.9% and >4 h in 87.1%. Davey, 2021 Pre-existing headaches were not reported, and post-use PPE headaches were reported in 79%. PPE wearing time was <4 h in 26.8% and >4 h in 73.2%. Çiriş Yildiz, 2021 Pre-existing headaches were not reported, and post-use PPE headaches were reported in 74.1%. PPE wearing time was not reported. Shubhanshu, 2021 Pre-existing headaches were not reported, and post-use PPE headaches were reported in 23%. PPE use was reported for more than 4 hours. Bharatendu, 2021 Pre-existing headaches were not reported, and post-use PPE headaches were reported in 79.9%. PPE wearing time was not reported. Rosner, 2021 Pre-existing headaches were not reported, and post-use PPE headaches were reported in 71.4%. PPE use was reported for more than 4 hours. Bai, 2021 Pre-existing headaches were not reported, and post-use PPE headaches were reported in 69.2%. PPE wearing time was <6 h in 25.4% and >6 h in 74.6%. Agarwal, 2021 Pre-existing headaches were not reported, and post-use PPE headaches were reported in 28%. PPE wearing time was <4 h in 28% and >4 h in 72%.	

					Arif, 2021 Pre-existing headaches were not reported, and post-use PPE headaches were reported in 62.5%. PPE wearing time was not reported. Peres, 2021 Pre-existing headaches were not reported, and post-use PPE headaches were reported in 37.5%. Headache prevalence by mask type was 37.5% for N95 and 19.4% for surgical masks. PPE wearing time was <4 h in 1.6% and >4 h in 98.4%. Cigiloglu, 2021 Pre-existing headaches were not reported and post-use PPE headaches were reported in 47.6%. Mean PPE wearing time was 9.0 (SD 2.0) hours. Ipek, 2021 Pre-existing headaches were not reported, and post-use PPE headaches were reported in 59% among N95 users and 15% among surgical mask users. PPE wearing time was <4 h in 100% of participants. Aggregative (meta-analysis) According to the meta-analysis, the prevalence of headache after PPE use was 48.27% (95% CI: 40.20–56.34; I^2 = 99.3%) and before PPE use was 30.47% (95% CI: 20.47–40.47; I^2 = 97.3%). The high I^2 values indicated very high between-study heterogeneity, and Begg tests suggested negligible publication bias for headache after PPE use (P = 0.133) and before PPE use (P = 0.531).	
Schoberer, 2022 Austria Rapid review and meta-analysis	24/06/2021 The authors assessed the effectiveness of PPE in terms of how well it protected HCWs from COVID-19 infections as well as the side effects	11 / 10 NR	HCWs who provide direct patient care. N = 9,132 Any health care setting	Face masks Eye protection Gloves Gown Face protection Disposable non-surgical face mask	**Adverse effects in general** The review authors searched for reports of adverse events associated with PPE use in the included studies (Burke, 2020; Chatterjee, 2020; Chen, 2021; El-Boghdadly, 2021; Guo, 2020, Heinzerling, 2020; Ng, 2020; Ran, 2020; Wang, 2020a; Wang, 2020b). However, none of these studies reported adverse events or acceptance outcomes related to PPE use. Because this outcome was explicitly sought during	Critically Low

	experienced by HCWs who used PPE in clinical settings.		Hospital ICU COVID-19 Ward Neurosurgery Outpatient settings Hospital room Context: Covid-19	Surgical mask N95 mask N95 respirator Hand hygiene PPE according to WHO minimum standard for aerosol-generating procedures Complete PPE (including masks, round caps, gloves, protective clothing, boot covers, goggles or face shields)	data extraction, the absence of reporting is itself an important finding. This lack of reporting may be partly explained by the exclusion of cross-sectional and qualitative studies, which are more likely to capture user experiences and adverse effects.	
Shaukat, 2020 Pakistan Scoping review	03/2020 This scoping review aims to summarize the evidence of the physical and mental health impacts of COVID-19 pandemic on HCWs.	10 / 1 NR	HCWs N = 700 NR Context: Covid-19	Not specified, Infection-preventive measures included N95	**Skin damage** Lan, 2020 Prevalence of skin damage: 97% Nasal bridge most common site: 83.1% associated with more than 6 h of continuous PPE use. Prevention against the viral illness meant that HCWs had to wear personal protective equipment (PPE)PPE for a prolonged period. A cross-sectional study demonstrated skin damage in 97% of the medical staff, with the nasal bridge (83.1%), being the most commonly affected site. The most common presenting symptom was dryness or tightness and desquamation (70.3%), and these manifestations were associated with more than 6 h of continuous PPE use and more than 10 times/day hand hygiene	Critically low
Tezcan, 2022 Turkey Systematic review and meta-analysis	20/12/2021 To examine pressure ulcers due to the use of protective equipment in HCWs during COVID-19 pandemic and the precautions taken to prevent them.	17 / 11 Multi-country (unspecified)	HCWs N = 23,717 NR Context: Covid-19	PPE Masks (including N95) N95 Surgical mask FFP3 mask Face shield	**Pressure ulcers** Coelho, 2020 Device-related pressure ulcers (DRPUs) were reported with a prevalence of 69.4%. Most cases were mild (Grade I: 67%), followed by moderate (Grade II: 8.4%) and severe deep tissue injuries (0.4%). On average, 2.4 ulcers were observed per HCW. The most frequent locations were the nasal bone (31.7%), forehead (18.5%), ear (18.4%), zygomatic	Critically Low

					area (12.1%), cheeks (11.5%), and nasal wings (7.8%). Risk factors included PPE use for more than 6 hours per day and longer working hours. Jiang, 2020a PPE-related skin injuries had an overall prevalence of 42.8%. Identified risk factors included longer PPE use and the use of higher-protection PPE. Jiang, 2020b Device-related pressure ulcers had a prevalence of 30%, with most cases being mild (Grade I: 82.9%), followed by moderate (Grade II: 15.94%), severe (Grade III: 0.49%), and deep tissue injuries (0.67%). The most common locations were the nasal bridge (24.4%), cheeks (23.4%), auricles (20.3%), and forehead (10.9%). Risk factors included PPE use for more than 4 hours and the use of higher-protection PPE. Hu, 2020 Adverse skin reactions associated with N95 masks had an incidence of 95.1%. The most common reactions were scars on the nasal bridge (68.9%) and itching on the face (27.9%). Kong, 2021 PPE-related pressure ulcers were reported in 92.8% of HCWs. The most frequent lesion type was erythema (91.6%), followed by complete serous blisters (8.4%). Pressure ulcers in the facial region also increased HCWs' concerns about social appearance. Bambi, 2021 PPE-related outcomes included pressure ulcers, headache, and itching. Severe DRPUs (greater than Grade II) were reported in 6.9% of cases. PPE-related pain was reported by 92.8% of participants, DRPUs by 77.1%, headache by 27.8%, and itching by 15.8%. The most common ulcer locations were the nose and ears, and the first DRPUs developed on average within 3 hours. Skiveren, 2021	

					Adverse skin reactions (ASR), including spots, pimples, red and irritated skin, and device-related pressure ulcers, had a prevalence of 61.9%. Spots and pimples were most common among surgical mask users (37.2%), while red and irritated skin were most frequent among FFP3 mask users (27.3%). DRPUs were reported for surgical masks (1.7%), FFP3 masks (2.7%), and face shields (0.6%). Healthcare professionals using full PPE for more than 6 hours had four times higher ASR. Jiang, 2021 Adverse skin reactions included skin ulcers and DRPUs. Mild DRPUs accounted for 44.1%, moderate for 12%, and severe for 0.2%, with deep tissue injuries in 0.3%. Skin ulcers had a prevalence of 79.5%, moisture-associated skin damage 19.4%, skin tears 3.5%, and multiple skin injuries 68.5%. The most affected areas were the nasal bridge, cheeks, ears, and forehead. Using goggles together with N95 masks and wearing PPE for more than 4 hours increased the risk of ASR. Abiakam, 2021 Adverse skin reactions included redness, itching, and pressure damage. The nasal bridge (69%) and ears (30%) were the most affected areas in prevalence analyses. In a prospective component, the most frequent reactions were redness (33%), itching (22%), and pressure damage (12%). Risk factors included the type and model of PPE, longer daily PPE use, uninterrupted PPE use time, and consecutive days of PPE use. Etgu, 2021 Adverse skin reactions were reported due to several types of PPE, including surgical masks (47%), N95 masks (34.6%), FFP3 masks (22.5%), and face shields (12.4%). The most common reactions were erythema (64.4%), dryness (57.9%), acne (35.6%), ulcers (34.7%), peeling (28.2%), rhinorrhea (21.1%), and lichenification (16.5%). Risk factors included wearing PPE for more than 6 hours per day and working more than 3 days per week.	

					Smart, 2020 No adverse skin reaction outcomes related to PPE use were reported.	
Yapanto, 2022 Indonesia Systematic Review	11/2021 To understand the extent of facial skin injury induced by protective mask-wearing among primary HCW during the Pandemic of COVID-19.	14 / 14 NR	Medical staff who wore level 2 or 3 PPE while working at the frontline against COVID-19 N= 10,430 NR Context: Covid-19	Level 1–3 PPE Level 3 PPE Protective masks Surgical mask medical mask Face mask Cotton mask N95 mask FFP2 mask FFP3 mask KF94 respirator KF80 respirator PAPR Eye protection Face shield Goggles Glasses Gloves Gown Apron Cap Medical protective clothing Combinations reported: N95 + surgical mask Surgical + FFP2/FFP3 mask	**Skin injuries** Jiang, 2020 Device-related pressure injuries (DRPI) were prevalent among HCWs wearing PPE against COVID-19. Risk factors for facial skin injury included male sex, wearing level 3 PPE, longer wearing time (>4 hours), and sweating ($p<0.05$). Battista, 2021 The most affected individuals were HCWs wearing N95 respirator masks for more than 6 hours per day ($p<0.05$). Abiakam, 2021 Facial skin injury was reported and was significantly associated with longer daily PPE use, particularly when PPE was worn for more than 8 hours ($p<0.05$). Ippolito, 2021 Pressure injury was reported in 59% of participants in the facial area. This was significantly associated with wearing N95 masks in the ICU for more than 6 hours ($p<0.05$). Han, 2021 Skin injuries significantly differed between respirator-covered and uncovered skin areas after 4 and 8 hours of PPE use ($p<0.05$). Choi, 2021 Contact dermatitis, acne, and wounds around the face were reported among HCWs. Facial skin injuries were significantly associated with daily N95 mask use, PPE use for more than 6 hours per day, and cotton masks, which increased acne and wounds around the face ($p<0.05$). Uthayakumar, 2021 Facial skin injury was reported, and 70% of participants reported significant adverse effects on their work or study ($p<0.05$). These outcomes were associated with wearing	Critically Low

					N95 masks for more than 6 hours. Purushothaman, 2021 Excessive sweating around the mouth was reported in 67.6% of participants after using protective masks, which was associated with poorer adherence and increased risk of facial skin injury ($p<0.05$). This was particularly associated with wearing an N95 mask combined with a surgical mask for more than 4 hours per day. Techasatian, 2020 Facial skin injury occurred in 48.9% of participants after wearing protective masks for 4–8 hours ($p<0.05$). This was associated with wearing N95 or surgical masks for extended periods. Singh, 2020 The most commonly noted dermatoses were irritant contact dermatitis affecting the face. Goggles and N95 masks were identified as the most common PPE associated with skin injuries ($p<0.05$), particularly when worn for an average of 8.76 hours. Coelho, 2020 Pressure injuries related to PPE were common, with an average of 2.4 injuries per healthcare professional. Wearing PPE for more than 6 hours per day was a significant contributing factor ($p<0.05$). Yuan, 2020 A total of 94.57% of healthcare professionals experienced discomfort while wearing level 3 PPE, including facial skin injuries, respiratory difficulties, heat stress, dizziness, and nausea. These effects were associated with wearing N95 masks, goggles, gloves, face masks, gowns, and medical protective clothing for more than 8 hours. Shanshal, 2020 Pressure injuries in the facial skin were reported in 51% of participants after prolonged PPE use (>8 hours), and 82.5% reported facial skin injuries overall ($p<0.05$). These outcomes	

					were associated with prolonged use of PPE including N95 masks, goggles, gloves, face masks, gowns, and protective clothing. Christopher, 2020 No specific outcomes were reported; however, the level of PPE worn and the daily duration of PPE use (Level 1–3 PPE worn for ≥7 hours per day) were identified as factors associated with adverse skin reactions. Discomfort Yuan, 2020 A total of 94.57% of healthcare professionals experienced discomfort while wearing level 3 PPE, including facial skin injuries, respiratory difficulties, heat stress, dizziness, and nausea. These effects were associated with wearing N95 masks, goggles, gloves, face masks, gowns, and medical protective clothing for more than 8 hours. **Sweating** Purushothaman, 2021 Excessive sweating around the mouth was reported in 67.6% of participants after using protective masks, which was associated with poorer adherence and increased risk of facial skin injury ($p<0.05$). This was particularly associated with wearing an N95 mask combined with a surgical mask for more than 4 hours per day.	
Yu, 2021 United States Systematic review	09/04/2020 To identify important causes of occupational dermatoses from facial protective equipment	11 / 6 China, USA, Singapore, Others	HCWs N = 39,794 NR Context: Covid-19 and SARS	Masks Respirators Surgical mask N95 Paper masks	**Occupational dermatitis** Lin, 2020 Adverse skin reactions (ASR) were reported in 280 of 376 HCWs (74.5%). The most affected areas were the hands, cheeks, and nasal bridge. The most common reactions included dryness or scaling, papules or erythema, and maceration. Regions and hospitals with more severe outbreaks reported more cases, likely due to longer working hours and stricter PPE requirements. PPE use for more than 6 hours was significantly associated with an increased risk of ASR. Lan, 2020 Skin damage was reported in 526 of 542 HCWs (97%). The nasal bridge was the most affected area (83.1%), followed by hands, cheeks, and forehead. The most frequently	Critically Low

					reported symptoms were dryness and tightness (70.3%) and desquamation (61.6%). PPE use for more than 6 hours was significantly associated with increased skin damage. Foo, 2006 Among 340 HCWs during the 2003 SARS epidemic, N95 respirators were worn for an average of 8 hours per day. Adverse skin reactions occurred in 109 of 307 participants (35.5%), with the most common reactions being acne (59.6%), facial itching (51.4%), and rash (35.8%). No skin reactions were reported among users of surgical or paper masks. Warshaw, 2019 Allergic contact dermatitis (ACD) or irritant contact dermatitis (ICD) related to PPE was reported in 88 of 38,533 patients (0.2%) from the North American Contact Dermatitis Group (2001–2017), of whom 30% were HCWs. PPE such as masks and respirators were associated with ACD (77%), ICD (28.7%), or both (11.3%). The most commonly affected areas were the face (28%), hands (17%), and arms (13%). Donovan, 2007 A case report described allergic contact dermatitis to formaldehyde in a 49-year-old female physician during the 2003 SARS epidemic. The patient experienced recurrent generalized dermatitis affecting the face, neck, flexures, trunk, and legs while wearing an N95 respirator. Tan, 2004 Two females HCWs developed acneiform eruptions on facial areas covered by an N95 respirator after approximately three months of continuous use in the hospital setting.	
Yu 2021B China Systematic review	04/08/2020 To summarize the pressure injuries caused by COVID-19 and the corresponding preventive measures and treatments.	12 / 9 Malaysia, Spain, UK, China, Australia, Italy, France	People who developed pressure injuries due to COVID-19 (included HCW)	FFP Mask (not specified)	**Pressure injuries due to COVID-19** Lam, 2020 Pressure injuries were reported at the bridge of the nose. Grade I injuries were observed in 4 participants and grade III in 1 participant. The duration of PPE use associated with these injuries was 3 hours (n = 1), 4–5 hours (n = 2), and >6 hours (n = 2).	Critically Low

			N = 7,692 NR Context: Covid-19		Yun, 2020 Pressure injuries were reported on the nose, forehead, cheeks, and auricle. In the experimental group, grade I injuries occurred in 3 participants and grade II in 1 participant. In the control group, grade I injuries occurred in 12 participants, grade II in 8, and grade III in 1. The duration of PPE use associated with these injuries was 8 hours. Jiang, 2020 (5) Pressure injuries occurred on the bridge of the nose, cheeks, auricle, forehead, and other sites including the mandible, groin, and neck. Grade I injuries were reported in 2,866 cases, grade II in 551, grade III in 17, and deep tissue injury in 23 cases. These injuries were associated with PPE use exceeding 4 hours (n = 3,632) and ≥4 hours (n = 674). Tang, 2020 Pressure injuries were reported on the nasal bridge, zygomatic arch, and auricles. Grade I injuries were observed in 51 participants, while grade II or higher injuries were observed in 11 participants. The median PPE wearing time was 6 hours (range 0–17 hours). Jiang, 2020 (18) Pressure injuries were reported on the bridge of the nose, cheeks, ears, forehead, and other sites. Grade I injuries occurred in 667 participants, grade II in 98, grade III in 1, and deep tissue injury in 5 participants. PPE use duration was ≤4 hours (n = 326), 5–8 hours (n = 2,140), and ≥9 hours (n = 471). Feng, 2020 Pressure injuries were reported on the nose, cheeks, auricle, forehead, and neck. Grade I injuries occurred in 39 participants and grade II in 16. The duration of PPE use associated with these injuries ranged from 4 to 4.5 hours. Yu, 2020 Pressure injuries were reported on the nose, cheeks, auricle, forehead, and neck. Grade I injuries occurred in 116 participants, grade II in 20, and grade IV in 1 participant. Duration of PPE use was not reported.	

					Xia, 2020 Pressure injuries were reported on the nose, cheeks, forehead, and auricle. Grade I injuries occurred in 12 participants and grade II in 3. PPE use duration was <4 hours (n = 20), 4–5 hours (n = 22), 6–8 hours (n = 5), and ≥9 hours (n = 7). Zheng, 2020 Pressure injuries were reported on the nose, cheeks, and auricle. Grade I injuries occurred in 10 participants, grade II in 2, and deep tissue injury in 1 participant. These injuries were associated with PPE use for 6–8 hours. Aggregative Pressure injuries among HCWs during COVID-19 were mainly associated with prolonged use of PPE (particularly N95 masks, surgical masks, and goggles) which generate pressure, friction, shear, moisture, and temperature changes on the skin. Lesions most commonly occurred on the nasal bridge, cheeks, forehead, and ears, especially with PPE use exceeding four hours, working in COVID units, higher PPE levels, sweating, and lack of experience with facial protective equipment. Prevention strategies remain limited and poorly standardized, although preventive dressings and proper mask strap adjustment may reduce risk.	

Table 3. Other Outcomes Related to Acceptability

Other Outcomes Related to Acceptability						
Author, Year Country Type of review	**Year of last search Purpose of the review**	**No. of Primary Studies Included in Review/ No. of primary studies of interest to our PICO Country/ies**	**Populations and setting Disease/ Outbreak context**	**Interventions**	**Main findings**	**Evaluation of the quality of the review**
Alberta Health Services, 2020 Canada Rapid review	NR, studies published between 2003 and 2020. This report is intended to collate evidence to inform the PPE Task Force on whether current PPE guidelines, in respect to exposure to a probable or confirmed COVID-19 patient, should be modified.	59 / 35 Canada, UK, USA, Italy, China, Singapore, France, Australia.	Patients diagnosed with and being treated for influenza, SARS-CoV-1, SARS-CoV-2, MERS, and RSV Acute care, long- term care HCWs. N (14318) NR	Full PPE, continuous masking, and continuous full PPE patient isolation (assumption that HCW wearing either full PPE, continuous masking, and continuous full PPE).	**Communication difficulties** Bandaru, 2020 There was a statistically significant increase in speech reception threshold and a decrease in speech discrimination scores with the use of PPE; the p values obtained for both parameters were less than 0.0001 on paired t-test. There were no statistically significant differences in the changes in speech reception threshold and speech discrimination score values obtained with and without using PPE when comparing between different age groups (20–40 years vs 41–60 years), sex, and occupation	Critically Low

					Corley, Hammond & Fraser, 2009 Communication was reported as challenging when using PPE. Hampton, 2020 PPE significantly affected speech processing in simulated operating theatre settings but not in simulated office, emergency department, or intensive care settings. - Bamford–Kowal–Bench sentence test scores were significantly lower for subjects wearing PPE (median score = 58) compared to those without PPE (median score = 92) in an operating theatre simulated environment (Z = −2.02, p = 0.04) Kang, 2018 Wearing the PAPR made them difficult to communicate with patients and other nurses in isolation anterooms. They said that it was not easy to communicate with patients on a respirator while wearing PPE as noise from the respirator or other machines and face shields of their PAPR impeded communication Khoo, 2005 A total of 14% of respondents found the hearing impairment when using the 3M PAPR to be significant or unacceptable, while it was significant for only 5% when using the Stryker PAPR. Concomitant use of the N95 mask impacted vocal volume and ability to speak - About two-thirds of respondents agreed (22%) or strongly agreed (42%) that they looked frightening to their patients whenever they used the PAPR. Lawrence, 2020 Communication was most degraded using the full-face snorkel mask, with participants' performance around 50% correct across all conditions and listener positions. On average, communication scores for the half-face mask (FFP2 or FFP3) were superior to both of the full-face mask options. Palinkas, 2020 Providers reported changes in patient–provider interactions due to social distancing and PPE use.	

					Shack, 2020 82% reported that mask-wearing interrupts their ability to interact with children - 62% reported that children are more fearful of mask wearing clinicians - 59% experienced difficulty effectively assessing or treating patients while wearing a mask ($p<0.005$). -Significant differences in clinicians' reported difficulty in engaging with patients when comparing mask wearing during the pandemic to previous routine practice. This effect was more pronounced at younger ages; for patients aged 6 months to 2 years, 20% of all clinicians reporting their experiences as 'difficult' or 'very difficult' with mask-wearing during the pandemic, as opposed to 4% during previous routine practice Yánez Benítez, 2020 54% reported communication issues, 63% reported visual interference, and 18% reported concerns about situational awareness when using PPE.	
Alberta Health Services 2021 Canada Rapid Review	29/06/2021 This review is intended to supplement a previous SAG report that examined the evidence for PPE guidance and changes in acute and long-term care.	27 / 6 USA, Korea, Switzerland, Germany, Italy, UK, Netherlands, Canada, Luxembourg, Australia	HCWs N = NR Context: NR	N95 respirators Surgical mask	**Communication Difficulties** Hayirli, 2021 Continuous masking and PPE have a detrimental effect on team communication, social cohesion, and therapeutic relationships	Critically Low

Arikpo, 2025 Nigeria Qualitative evidence synthesis	05/09/2022 This review aimed to (1) synthesize available qualitative research exploring the perceptions and experiences of health and care workers on the use of PPE and physical distancing interventions in healthcare settings in the context of COVID-19 and (2) identify the contexts and conditions that facilitate or hinder uptake and adherence to these interventions.	19 / 14 India, Iran, Indonesia, China, Turkey, Australia, Finland, Portugal, Italy, Spain, UK, US, Belgium, France, Luxembourg, S. Korea, Ireland	Health and care workers involved in patient care and those not involved in patient care. Healthcare policymakers. Health facility clients (including residents of care homes, recipients of care – inpatients, and outpatients) and visitors. Community members – general public and members of households. N (633) Health facilities and care home	Physical barriers and distancing for infection prevention, including PPEs (e.g., face masks, coveralls, gowns, shoe covers, N95 respirators, gloves, goggles, face shields) Physical distancing (e.g., keeping a distance of a least 1 m or 2 m between patients or persons) Engineering controls (air cleaning and purifier technologies; spatial separation using physical barriers).	**Institutional Policy / Mandate on RPE** Fan, 2020 The layout of the health facility affected PPE use. Participants reported that the organization of spaces influenced their ability to follow PPE protocols, and that the designation of clean and contaminated areas was interpreted inconsistently among health care professionals, leading to variations in adherence to established rules. Sivaraman, 2022 Institutional support and role modelling facilitated PPE use. The regular release of updated institutional guidelines aligned with the global situation encouraged adherence, and supervision by senior physicians promoted compliance, with junior staff reporting that observing their seniors using PPE reinforced their own use. Sharma, 2022 The layout of the health facility affected PPE use. Participants reported that changing areas were sometimes located in open spaces without privacy, which created difficulties and discomfort when changing PPE. **RPE Supply / Availability** Setiawan, 2021 The availability and supply of PPE influenced its use among health workers. Romeu-Labayen, 2022 Inequality in access to PPE was reported. Participants described differences in the availability of protective equipment across settings, noting that some health professionals had access to new and adequate PPE while others had very limited resources, highlighting disparities in protection and safety.	Critically Low

					Romeu-Labayen, 2022. Inequality in access to PPE was reported. Participants described disparities in the availability and quality of protective equipment across settings, noting that some HCWs had access to new and adequate PPE while others had very limited resources, which created a sense of inequity in protection and safety. **Communication Difficulties** Sivaraman, 2022. Masks and PPE affected communication and the relationship between HCWs and patients. Setiawan, 2021. Masks and PPE affected communication and the relationship with patients. HCWs reported that speaking while wearing a mask and maintaining physical distance made it difficult for patients to understand them, sometimes leading to misunderstandings and tension. Ribeiro, 2021. HCWs described learning strategies to communicate effectively with patients while wearing masks. Therapists reported strengthening active listening and interviewing skills, encouraging patients to verbally express emotions, and allowing more time to understand patients' needs during interactions. Ferrari, 2021. Masks and PPE affected communication and the relationship between HCWs and patients. Ozdemir, 2022. Masks and PPE affected communication and the relationship between health workers and patients. Hayirli, 2021. Masks and PPE affected communication and the relationship between HCWs and patients. Romeu-Labayen, 2022. Masks and other PPE were reported to challenge effective communication between HCWs and patients.	

					Markkanen, 2021. Masks and PPE affected communication and the relationship between health workers and patients. **Organizational / System-Level Contextual Factors** Broom, 2022. A gap between PPE guidelines and their implementation in practice was reported. Fan, 2020. A gap between PPE guidelines and protocols and their implementation in clinical practice was reported. Romeu-Labayen, 2022 (a). A gap between PPE guidelines and their implementation was reported. Participants described situations in which protocols required strict PPE practices, such as discarding respirators after each use, but shortages made this impossible. As a result, health workers adapted protocols based on available resources and practical constraints. Romeu-Labayen, 2022 (b). A gap between PPE guidelines and protocols and their implementation in practice was reported. **Other Contextual Factors** Sivaraman, 2022 Individual HCW factors affected PPE use. Clinicians described dilemmas between prioritizing immediate patient care and taking time to don PPE, particularly in emergency situations where urgent treatment limited the opportunity to follow full protective procedures. Goodarzin, 2022. Individual HCW factors affected PPE use. Health workers reported that PPE made clinical tasks more physically demanding, describing sensations of suffocation, exhaustion, and reduced work performance, particularly during intensive procedures such as resuscitation. Romeu-Labayen, 2022. Individual HCW factors were reported to influence PPE use.	

Bakhit, 2021 Australia Systematic review and meta-analysis	1/01/2021 To assess the safety, the risks and/or the respiratory physiological impact of FMs in age ranges or disease categories.	63 / 8 NR	Special populations (including HVCW) N (NR) NR	Respiratory protective equipment	**Communication Difficulties** Three studies reported communication impact but did not specify this impact (MacIntyre, 2011; Nickell, 2004; Radonovich, 2009).	Low
Balestracci, 2023 Italy Systematic review	11/05/2020 To synthesize evidence concerning the range of filtering respirators suitable for patient care and guide the selection and use of different respirator types	39/13 NR	HCWs N (2657) NR	Respirators Use of disposable respirators Use of reusable respirators Selection and implementation of different respirator types of Existing respirator standards	**Communication Difficulties** Two studies mentioned communication difficulties but did not specify frequency or other information (MacIntyre, 2011; Honarbakhsh, 2017)	Critically Low

Burton, 2021 UK Rapid review	11/05/2020 To synthesize evidence concerning the range of filtering respirators suitable for patient care and guide the selection and use of different respirator types	39/13 NR	HCWs N (2657) NR	Respirators Use of disposable respirators Use of reusable respirators Selection and implementation of different respirator types of Existing respirator standards	**Communication Difficulties** Palmiero, 2016 The Speech Intelligibility Index (SII) for filtering facepiece respirators (FFR) was 0.7 (normal = 1), slightly lower than surgical masks but still equivalent to more than 92% of sentences being intelligible. Elastomeric respirators showed lower intelligibility (SII 0.44–0.48), described as "barely good" intelligibility. Radonovich 2019 Respirators decreased speech intelligibility by 1% to 17%. Performance ranking was control ≥ N95 > PAPR > elastomeric half-face respirator (EHR) with speech diaphragm > EHR without speech diaphragm. Baig, 2015 Approximately 20%–30% of participants reported that respirators interfered with breathing and communication. Brosseau, 2015 Around 20%–30% of participants reported interference with communication and moisture buildup when using respirators. Radonovich, 2019 About 20% of participants reported hearing difficulties when using PAPR, and 30% reported speech difficulties when using elastomeric half-face respirators (EHFR). Aggregative findings. Overall, respirator use had a measurable impact on clinical communication, including a meaningful reduction in speech quality with EFR and PAPR, and hearing difficulties with PAPR, with subjective communication difficulties reported in approximately 20%–30% of users. **Cultural / Behavioral Contextual Factors Fix** PPE use was shaped by a complex intersection of personal, social, and cultural processes, influencing how health workers understood, accepted, and implemented protective practices. Hines, 2019 Participants described trade-offs between usability (including impacts on patient care) and protection, with diverse opinions about this balance.	Critically Low

					PPE was sometimes perceived as a “port in a storm rather than the new normal,” suggesting it was viewed as a temporary protective measure rather than a sustainable long-term practice Aggregative. Experimental studies reported a meaningful drop in speech quality with elastomeric facepiece respirators (EFR) and powered air-purifying respirators (PAPR), as well as hearing difficulties with PAPR. Surveys indicated subjective communication difficulties among approximately 20%–40% of users, suggesting a notable impact on clinical communication, although the perceived extent varied across studies. **HCW and organizational perceptions regarding use** HCW balance between discomfort and extra protection. Both HCW and organizations indicate the importance of practical issues (storage, access) and social context of norms and culture. **Adherence to standards in practice and the effect of training** Failure to follow guidelines for safe use is common both in donning / doffing and during use. Repeated training appears to be necessary to ensure continuing safe respirator fit.	
CDC, 2023 USA Systematic Review and Metanalysis	03/08/2023 HICPAC’s Isolation Guideline Update Workgroup requested CDC conduct a systematic literature review to answer the question: for healthcare personnel caring for patients with respiratory infections, what is the	40/27 Indonesia, France, Canada, Thailand, The United States, Switzerland, India, Pakistan, Israel, Egypt, China, Greece, Italy	Healthcare personnel N (NR) They are mentioned emergency departments and respiratory wards of included hospitals, medical units, and pediatric units of eight tertiary care hospitals, outpatient medical	N95 respirators and face protection with similar levels of protection (e.g., FFP2/FFP3	**Communication Difficulties** MacIntyre, 2011 Trouble communicating with the patient: All N95 respirators: 62/775 (8.0%) Medical mask: 9/303 (3.0%) $p < 0.01$ Aggregative 5 studies:(MacIntyre, 2011; Aliabadi, 2022; Nwosu, 2021; Peres, 2022; Su, 2021) Evidence from five studies (N=4,657) on difficulty talking is mixed. Four studies (N=4,581) reported greater communication difficulty with N95 use, including one quasi-experimental study (N=20) showing ~10% lower speech intelligibility with N95 vs. surgical masks in background noise ($p<0.01$) (45), and two RCTs supporting higher self-reported difficulty (31, 61). However, one study (N=76) found no difference (46.4% vs. 47.9%, $p=0.9$) (56).	Low

	effectiveness of medical/surgical masks compared with N95 respirators in preventing infection?		centerers, including primary care facilities, dental clinics, adult and pediatric clinics,			
Fakherpou, 2023 Iran Systematic review	21/03/2023 The authors systematically reviewed the studies performed on respirator fitting and affective factors during COVID-19	137 / 9 The United States, Australia, United Kingdom, Canada, China, Iran, Japan, South Korea, Italy, India, Germany, Spain, Brazil, the Netherlands, Singapore, Turkey, Saudi Arabia, France, Malaysia, Pakistan, and Switzerland	HCWs N = 2,888 NR	ators H	**Training / Education** Williams, 2021 After online training and quantitative fit testing, participants' knowledge, donning and doffing skills, and user seal checks (USCs) improved significantly ($p < 0.01$).	

Franco, 2021 Brazil Scoping review	12/06/20 To map the use of PPE by healthcare professionals to combat COVID-19 in healthcare settings.	13 / 11 90 different countries across Africa, Asia, Europe, North America, Oceania, and South America.	HCWs N = 142,870 ICU, Hospitals and clinics (includes home care clinics, community pharmacies and health districts); Isolation wards; Emergency rooms; Frontline; pre-hospital and hospital care; Inpatient and outpatient. Context: Covid-19	FFP2/N95 mask FFP3 (or equivalent standard) Surgical mask Face shields/goggles Breathing certified masks PPE (including masks)	**Institutional Policy / Mandate** Tabah, 2020 Recommendations for personal protective equipment (PPE) PPE have varied considerably both between and within countries. Sharma, 2020 Variability in protocols. **RPE Supply / Availability** Felice, 2020 Most reported having access to PPE, but few considered it adequate and of good quality. Delgado, 2020 Most participants reported having access to personal protective equipment (PPEPPE); however, many healthcare professionals indicated that they did not have the equipment required and recommended by the World Health Organization (WHO). El-Boghdadly, 2020 There was insufficient use of PPE, and the combinations of protective equipment varied, making it impossible to assess whether the equipment was used according to World Health Organization (WHO) standards. Sharma, 2020 Variability in the availability and provision of PPE. **Communication Difficulties** Parush, 2020 Trouble with communication: Difficulties in seeing what was happening, hearing, understanding speech, and comprehending the situation when using PPE	Critically Low

Gama, 2021 Belgium, Portugal and Netherlands Scoping review	07/2021 The authors aim to detect, analyze, interpret and summarize the potential effects of face masks on voice assessment parameters	9 / 3 NR	Health personnel N = 255 NR Context: NR	N95 respirators Surgical mask	**Communication Difficulties** McKenna, 2021 Speech intelligibility was significantly impaired with the use of face masks. it was observed a significant increase in vocal intensity while wearing a face mask in all studies assessing this outcome. Although a significant decrease in relative fundamental frequency (RFF) offset ten was observed in mask wearers after a workday (p = 0,001), especially when wearing KN95	Critically Low
Leung, 2022 Australia Scoping review	08/2021 To compile existing evidence on this emerging issue of workplace PPE-related psychological impacts	26 / 13 India, Italy, USA, Singapore, England, Austria, Turkey, Canada, Japan, Spain, Hong Kong, Iran, Other countries	HCWs N = 4,095 NR Context: Not specified	N95 Surgical mask PAPR Face masks in general (type not specified) Masks with valves Face shield mask Face respirators Face shield	**Communication Difficulties** Bandaru, 2020 Communication (speech intelligibility). N95; face shield Benítez, 2020 Perceived PPE-related impacts; communication; cognitive impact. Surgical mask; N95; face shield. Cheok, 2021 Perceived PPE-related impacts; communication. Surgical mask; N95; filtering face piece mask; cloth mask/scarf (not PPE). Nguyen, 2021 Communication (speech intelligibility, listening effort). Surgical mask; N95; PAPR Radonovich, 2009 Communication (speech intelligibility). Surgical mask; PAPR; N95	Critically Low

					Schlögl, 2021 Communication. Face masks in general (did not mention type specifically) Singh, 2021 Communication; perceived PPE-related impacts. Surgical mask; N95; masks with valves. Aggregative Impact of PPE: Of the stressors assessed, over half of the articles assessed the impact of PPE on communication (16 articles, 62%). Most of these articles assessed the impact on speech intelligibility, facial and emotion recognition, and listening effort when PPE is worn. Psychological impact of masks and respirators: There were fifteen articles related to communication impacts associated with respiratory PPE use. These studies specifically investigated communication in general, emotion and facial recognition, listening effort, sentence recall, and speech intelligibility. Most articles reported that there was a negative impact on communication between individuals when facial PPE was worn (10 articles, 67% of 15 articles). Like the previously discussed hearing protection related studies, impacts on speech intelligibility become more apparent in high levels of background noise, while in low background noise, masks had little to no effect on speech intelligibility (Thomas et al. 2011).	
Shaw, 2024 United States Scoping Review	02/2022 To identify effective communication practices while wearing face masks.	39 / 7 USA, Germany, UK, India, Australia, Switzerland	General population (including HCW) N = 585 NR Context: not specified	N95 mask Cup-shaped N95 Duckbill N95 Facemasks Surgical mask Transparent mask PPE portraits (face portraits affixed to PPE)	**Communication** Chu, 2021 Healthcare providers with normal hearing and hearing impairment reported a preference for wearing transparent masks and communicating with patients wearing transparent masks. All groups were better able to identify emotions when using transparent N95 masks compared with standard N95 masks. George, 2021 Physicians reported a significant improvement in communication between colleagues and greater perceived patient happiness after implementing PPE portraits (face portraits affixed to PPE). Godsell, 2013 HCWs described facemasks as preventing patients from seeing facial expressions and hearing clearly, which impaired rapport and therapeutic relationships. Providers suggested strategies such as using humor, apologies, explanations, or speaking for longer or more frequently to	Critically Low

					counteract the communication barriers created by PPE. Kratzke, 2021 Patients in the transparent mask group rated their surgeons significantly higher in providing understandable explanations, knowing the medical history, demonstrating empathy, and making trustworthy decisions compared with the surgical mask group. However, patients did not rate surgeons using transparent masks significantly higher in listening, answering questions, showing respect, or making them feel comfortable. Surgeons themselves reported preferring surgical masks over transparent masks. Radonovich, 2010 Speech intelligibility did not differ between surgical masks, cup-shaped N95 respirators, and duckbill N95 respirators. Speech intelligibility decreased when a surgical mask was worn over an N95 respirator, making speech intelligibility similar to that observed with PAPRs. Elastomeric half-mask respirators had the lowest speech intelligibility, although the use of a voice augmentation device improved intelligibility. Reidy, 2020 Perceptions of using PPE portraits (face portraits affixed to PPE) were generally positive, with participants agreeing that PPE portraits could improve meaningful connections with patients and their families. However, fewer than 10% of respondents reported personal experience using PPE portraits. Schlögl, 2021 Most HCWs agreed that it is more difficult to acknowledge emotions while wearing a facemask. The majority also rated the ABC video tutorial as beneficial; recommended strategies included using nonverbal cues and gestures, bending down to eye level, approaching from the front, ensuring the patient can hear clearly, and communicating clearly. Aggregative Across studies, facemasks were reported to influence communication and interpersonal interactions in healthcare settings. One randomized controlled trial found that patients interacting with surgeons wearing transparent masks reported better understanding of explanations, greater trust, and higher perceptions of empathy compared with standard surgical masks. Survey findings among healthcare providers also suggested a	

					preference for transparent masks and improved perceived communication when they were used, although surgeons themselves reported a preference for standard surgical masks. Experimental evidence indicated that speech intelligibility did not differ between surgical masks and N95 respirators but decreased when additional layers or respirator systems (e.g., N95 combined with surgical masks or PAPRs) were used. Qualitative and survey studies consistently reported that facemasks hinder recognition of facial expressions and emotions, potentially affecting therapeutic relationships. Interventions such as PPE portraits were perceived positively by healthcare providers and were associated with improved perceived communication among colleagues, although evidence of improved patient-reported communication outcomes was limited. Overall, surgical masks appeared to have the least impact on communication, while the acoustic effects of respirators such as N95/KN95 and other mask types were more variable.	

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APPENDIX 4. OVERLAP MATRIX

		Review																															
#	Primary Study (Author, Year)	Arikpo, 2025	Bakhit, 2021	Balestracci, 2023	Burton, 2021	Çakar 2025	Fakherpour 2023	Farah 2025	Farronato 2020	Franco 2021	Gama 2022	Iannone 2020	Jefferson 2023	Keng 2021	Kunstler 2022	Leung 2022	Licina 2020	Lu 2023	Montero-Vilchez 2021	Sahebi 2022	Schoberer 2022	Schwarz 2024	Shaukat 2020	Shaw 2024	Tezcan 2022	Wolf 2022	Yapanto 2022	Yu 2021	Yu 2021B	Alberta Health Services 2020	Alberta Health Services 2021	CDC	Total Reviews
1	Anshory, 2022																														x	1
3	Abdi, 2022																														x	1
4	Abiakam, 2021					x																		x		x						3
5	Agarwal, 2020																			x												1
6	Ahmed, 2020																								x							1
7	Al-Khalifa, 2020																								x							1
8	Alberta Health Services, 2020																													x		1
9	Alduwayhi, 2021																								x							1
10	Alizadeh, 2022																														x	1
11	Alroudhan, 2021																														x	1
12	Altun, 2022																														x	1
13	Ansari, 2022																														x	1
14	Arasli, 2020																												x			1
15	Arif, 2021																			x												1

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16	Atay & Cura, 2020					x														x								x			2
17	Bai, 2021																		x												1
18	Baig, 2010		x		x																										2
19	Bakaeen,2021																							x							1
21	Bambi, 2021					x																	x								2
22	Bandaru, 2020															x												x			2
23	Bansal, 2021																		x												1
24	Battista, 2021																	x							x						2
25	Bekes, 2021																							x							1
26	Benítez, 2020															x															1
27	Bharatendu, 2020																		x												1
28	Bharatha, 2022																													x	1
29	Bodas, 2022						x																								1
30	Bothra, 2020																											x			1
31	Broom, 2022	x																													1
32	Brosseau, 2015				x																										1
33	Bryce, 2008		x		x																										2
34	Burke,2020																			x											1
35	Burns, 2021					x																							x		2
36	Çaglar, 2022																		x												1
38	Casillas Santana, 2021																							x							1
39	Chan, 2021						x																								1
41	Chatterjee, 2020																			x											1
42	Chen, 2021																			x											1
43	Cheok, 2021															x															1
44	Choi, 2021																								x						1
45	Chou, 2020																											x			1

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46	Choudhury, 2020															x															**1**
47	Christopher, 2020																									x					**1**
49	Chu,2021																						x								**1**
50	Chughtai, 2018								x								x														**2**
51	Cigiloglu, 2021																		x												**1**
52	Cigiloglu, 2022																													x	**1**
53	Çiriş Yildiz, 2020																		x												**1**
54	Clark, 2021						x																								**1**
56	Cloet, 2022 A						x																								**1**
57	Cloet, 2022 B						x																								**1**
58	Coelho, 2020																							x		x					**2**
59	Corley, Hammond & Fraser, 2009																											x			**1**
60	Daugherty, 2009																											x			**1**
61	Davey, 2021																		x												**1**
62	Daye, 2020												x					x													**2**
63	Delgado, 2020									x																					**1**
64	Donovan, 2007																										x				**1**
65	Duan, 2021					x																									**1**
66	El-Boghdadly, 2020									x										x											**2**
67	Etgu, 2021																							x							**1**
69	Fan, 2020	x																													**1**
70	Farronato, 2020																											x			**1**
71	Felice, 2020									x																					**1**
72	Feng, 2020																												x		**1**
73	Ferguson, 2021												x																		**1**
74	Ferrari, 2021	x																													**1**
75	Fix, 2019				x																										**1**

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76	Foo, 2006					x																					x		x			3
77	Galehdar, 2020																												x			1
78	Garra, 2021													x																		1
79	Gelardi, 2020																													x	x	2
80	George,2021																					x										1
81	Giannaccare, 2020																												x			1
82	Godsell,2013																					x										1
83	Goodarzin 2022	x																														1
84	Guo, 2020																			x												1
85	Gupta, Singh & Gupta, 2020																												x			1
86	Hacibeyoglu, 2022																	x														1
87	Hajjij, 2020																	x													x	2
88	Hampton , 2020																												x			1
89	Han, 2021 A			x										x													x					3
91	Hayirli, 2021	x																												x		2
92	Heider, 2020										x																					1
93	Heinzerling, 2020																			x												1
94	Hines, 2017				x																											1
95	Hines, 2019				x																											1
96	Hines, 2020																												x			1
97	Hoedl, 2020														x																	1
98	Hoernke, 2021	x																														1
99	Honarbakhsh, 2017			x																												1
101	Houghton, 2020																												x			1
102	Hu, 2020					x				x				x											x				x			5
105	İpek, 2021			x											x	x			x												x	5
106	Ippolito, 2021																									x						1

107	Jafari, 2021					x													x											1
109	Jiang, 2020 A					x																		x				x			3
110	Jiang, 2020 B																							x		x			x		3
111	Jiang, 2020 C																											x			1
112	Jiang, 2021					x								x										x							3
113	Jin, 2020									x																					1
114	Jose, 2021																		x												1
115	Joy, 2021																		x												1
118	Kanaparthi, 2020																								x						1
119	Kang, 2018																												x		1
120	Kao, 2004		x																												1
121	Karayürek, 2021																								x						1
122	Kaur, 2022					x																									1
123	Khalid, 2021																													x	1
124	Khan, 2020																								x						1
125	Khoo, 2005																												x		1
126	Kiely, 2021												x																		1
127	Kısacık and Özyürek, 2022					x																									1
128	Klimek, 2020																												x		1
129	Kong, 2021																							x							1
130	Krajewski, 2020																	x													1
131	Kratzke,2021																					x									1
132	Kunstler, 2022																x														1
133	Kuo, 2020																												x		1
134	Lam, 2020																											x			1
135	Lan, 2020												x					x				x				x					4
136	Lawrence, 2020																												x		1

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137	Lee, 2020																												x			1
138	Lim, 2006		x	x	x				x																				x			5
139	Lin, 2020												x															x		x			3
141	Liu, 2022																														x	1
142	Loeb 2009											x																			x	2
143	Loeb, 2022																														x	1
145	MacIntyre, 2011		x	x							x	x																			x	5
146	MacIntyre, 2013		x									x																			x	3
147	Madathil, 2022																			x												1
148	Manerkar, 2021																														x	1
149	Maniaci, 2021													x																	x	2
150	Markkanen, 2021	x																														1
151	Martinez-Beneyto, 2021																							x								1
152	McKenna, 2021										x																					1
154	Mksoud, 2022																			x												1
155	Montero-Vilchez, 2021 A													x																		1
156	Montero-Vilchez, 2021 B																	x														1
157	Moore,2021					x																										1
158	Moraes, 2022																			x												1
160	Mushtaq, 2021												x																			1
162	Nasser, 2020																							x								1
164	Ng, 2022						x																									1
165	Ng,2020																			x												1
167	Nguyen, 2020									x																						1
168	Nguyen, 2021 A														x																	1
169	Nguyen, 2021 B										x																					1
170	Nickell, 2004		x																													1

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171	Nwosu, 2021													x															x	1
172	O'Neill, 2021												x																		1
173	Ong, 2020			x	x				x	x																			x		5
174	Ong, 2021																		x												1
175	Or, 2018			x																											1
176	Ozdemir, 2022	x																													1
177	Palinkas, 2020																												x		1
178	Palmiero, 2016				x																										1
179	Pandey, 2021																							x							1
180	Park, 2021 A																													x	1
182	Parush, 2020									x																			x		2
183	Pei, 2020												x																x		2
184	Peres, 2022																		x											x	2
185	Pimenta, 2021							x																							1
186	Powell, 2017															x															1
187	Purushothaman, 2020																												x		1
188	Purushothaman, 2021																								x						1
189	Radonovich, 2009 A														x																1
190	Radonovich, 2009 B		x		x																										2
191	Radonovich, 2010				x																		x								2
192	Radonovich, 2019 A		x									x																		x	3
193	Radonovich, 2019 B				x																										1
194	Ramirez-Moreno, 2020			x										x					x											x	4
195	Ran,2020																			x											1
196	Rapisarda, 2021																		x											x	2
197	Ravi, 2020																							x							1
198	Rebman, 2013		x		x				x						x																4

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UNIVERSIDAD DE ANTIOQUIA
Facultad de Medicina

Unidad de Evidencia y Deliberación para la toma de decisiones
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201	Reidy,2020																					x								1
202	Ribeiro, 2021	x																												1
203	Romeu-Labayen, 2022	x																												1
204	Rosner, 2020																		x											1
207	Schlögl, 2021														x						x		x							3
211	Setiawan, 2021	x																												1
212	Shack, 2020																											x		1
213	Shanshal, 2020																								x					1
214	Sharma, 2020								x																					1
215	Sharma, 2022	x																												1
217	Shenal, 2011							x																						1
218	Shubhanshu,2014																		x											1
219	Singh, 2020																								x					1
220	Singh, 2021													x																1
221	Sivaraman, 2022	x																												1
222	Skiveren, 2021																					x								1
223	Smart, 2020																					x								1
224	Su, 2021																												x	1
225	Suen, 2022						x																							1
226	Tabah, 2020								x										x								x			3
227	Tan, 2004																									x				1
228	Tan, 2006																										x			1
229	Tang,2020																											x		1
230	Tatti, 2022																												x	1
231	Techasatian, 2020																x								x					2
232	Thiagarajan, 2021													x					x											2
233	Thomas, 2011													x																1

234	Toksoy, 2021																		x												1
235	Unoki, 2020																												x			1
236	Uthayakumar, 2021																									x						1
237	Venesoja, 2021	x																														1
238	Wang, 2020 A																			x												1
239	Wang, 2020 B																			x												1
240	Warshaw, 2019																										x					1
241	Williams, 2021						x																									1
246	Xia, 2020 A					x																										1
247	Xia, 2020 B																											x				1
249	Yan, 2020													x																		1
250	Yánez Benítez, 2020																												x			1
251	Yeon, 2020						x																									1
252	Yildiz, 2020																												x			1
253	Yıldız, 2021					x																										1
254	Yu, 2020																											x				1
255	Yuan, 2020																									x						1
256	Yuan, 2021					x																										1
257	Yun, 2020																											x				1
258	Zaheer,2020																		x													1
259	Zaib, 2020													x																		1
260	Zheng, 2020																											x				1
261	Zuo, 2020													x																		1
TOTAL primary studies per review		**14**	**10**	**8**	**13**	**15**	**9**	**1**	**5**	**10**	**3**	**1**	**4**	**10**	**9**	**13**	**2**	**1**	**6**	**25**	**10**	**4**	**1**	**7**	**11**	**13**	**14**	**6**	**9**	**35**	**6**	**26**	**301**