Discover Psychology

Review

The impact of COVID-19 on health-related quality of life: a systematic review and evidence-based recommendations

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Abstract

Objective This systematic review examines the impact of COVID-19 on Health-Related Quality of Life (HRQoL) across different populations, focusing on demographic, socio-economic, and COVID-19-related factors.

Methods A comprehensive search of PubMed from 2020 to 2022 was conducted, identifying 37 studies that met the inclusion criteria. Studies were assessed using the Appraisal Tool for Cross-Sectional Studies, Newcastle–Ottawa Scale, and Consolidated Health Economic Evaluation Reporting Standards tools. Data extraction included study characteristics, HRQoL measures, and health state utility values.

Results Thirty-seven studies were conducted with a total of 46,709 individuals and 274 HSUVs ranging from 0.224 to 1. Research included Europe (n = 20), North America (n = 4), Asia (n = 11), South America (n = 1), and Africa (n = 1). Utility was measured using 15D (n = 3), EQ-5D-5L (n = 24), EQ-5D-3L (n = 8), VAS (n = 1), and TTO (n = 1). The review found significant decreases in HRQoL among COVID-19 survivors, particularly those with severe symptoms, due to persistent fatigue, breathlessness, and psychological distress. Quarantine and isolation measures also negatively impacted HRQoL, with increased anxiety and depression. Vaccination status influenced HRQoL, with vaccinated individuals reporting better outcomes. Socio-demographic factors such as age, gender, education, employment, marital status, and income significantly affected HRQoL, with older adults, females, and unemployed individuals experiencing lower HRQoL.

Conclusions COVID-19 has profoundly affected HRQoL, highlighting the need for comprehensive post-recovery rehabilitation programs and targeted public health interventions. Addressing socio-demographic disparities is crucial to mitigate the pandemic's impact on HRQoL. Policymakers and healthcare providers should implement strategies to support affected populations, emphasizing mental health support, social support systems, and vaccination programs.

Keywords Health-Related Quality of Life (HRQoL) · COVID-19 · Systematic review · Anxiety/depression · Public health interventions

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1 Introduction

The coronavirus disease 2019 (COVID-19) has posed a significant threat worldwide, prompting the World Health Organization (WHO) to declare it a public health emergency of international concern on 30 January 2020, and subsequently a pandemic on 11 March 2020 [1]. As of 19 November 2023, COVID-19 has over 772 million confirmed cases, and over six million deaths, with significant implications for public health and Health-Related Quality of Life (HRQoL) [2]. This unprecedented global health crisis has spurred research, with numerous studies investigating the pandemic's impact on HRQoL. This review aims to examine and synthesize findings related to HRQoL outcomes in various populations affected by the pandemic.

HRQoL is a critical measure that captures the impact of COVID-19 on individuals' well-being, guiding clinical and policy interventions through utility values ranging from 0 (death) to 1 (perfect health condition) [3]. Utility-based approaches primarily utilize structured vignettes, which are concise depictions of hypothetical health states, to elicit preferences regarding these states from either the general population or specific patient groups. These vignettes are instrumental in gauging how individuals value different aspects of health, offering insights into their health-related priorities and decision-making processes. Typically, this is achieved through established direct and indirect techniques. The direct methods include the EQ Visual Analog Scales (VAS) [4], Time Trade-Off (TTO) [5], and Standard Gamble (SG) [6]. Each method provides a unique way to quantify the value individuals assign to various health states, facilitating the comparison of health outcomes and the prioritization of healthcare interventions.

Conversely, Indirect methods utilize standardized instruments, such as the EQ-5D and SF-6D, which consist of a descriptive system and utility weights derived from population-based studies [7, 8]. These tools measure HRQoL across various dimensions (e.g., mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) and provide consistent and comparable measures across populations, facilitating broader application in clinical and policy-making contexts. Subsequently, the responses are converted into a single summary score using utility weights derived from population-based studies. These weights reflect societal preference for different health states, enabling the calculation of Quality-Adjusted Life Years (QALYs) for economic evaluations and healthcare planning. Indirect methods offer the advantage of providing consistent and comparable HRQoL measures across different populations and conditions, facilitating broader application in clinical and policy-making contexts. In general, direct methods provide individualized evaluations, indirect methods offer broader population-level insights. Together, these methods enrich the toolkit for HRQoL assessment, allowing for comprehensive evaluations.

There has not been an infectious disease outbreak like the COVID-19 pandemic in recent decades. Most previous studies on health status were conducted in social conditions with or without an unexpected pandemic and often focused on specific groups. This review aims to synthesize findings on HRQoL outcomes across diverse populations affected by COVID-19, including survivors, individuals with varying severities of infection, frontline workers, quarantined individuals, and vaccinated groups. By integrating these findings, we aim to identify patterns, risk factors, and protective factors associated with HRQoL outcomes. This review will offer evidence-based recommendations for healthcare providers, policymakers, and practitioners to address the broad health challenges posed by the pandemic, ultimately informing future research and policy decisions.

2 Methods

2.1 Search strategy

A systematic search of PubMed electronic bibliographic databases was conducted from 2020 to May 2022 with the aim of assessing HRQoL utility values using both direct measures (Standard Gamble [SG], Time Trade-Off [TTO], and Visual Analogue Scale [VAS]) and indirect measures (questionnaires such as EQ-5D, SF-6D, and HUI). To improve specificity and minimize the retrieval of non-relevant articles, terms were searched in titles and abstracts, e.g., [SG (abstract/title)]. This approach aimed to focus the search results on studies directly relevant to our research. Additionally, we extended our search to include key terms related to quality-adjusted life years and health state utility, such as 'preference-based quality of life', 'health state utilities', and 'health utility', following the recommendations of health economists [9, 10] (Table 1). Our search aimed to provide a comprehensive global overview, without geographical

Table 1 MEDLINE search strategy

	Search term (HRQoL)
1	quality adjusted life years
2	QALY
3	EQ-5D
4	euroqol
5	EQ5D
6	SF-6D
7	SF6D
8	"VAS" [Title/Abstract]
9	"VISUAL ANALOGUE SCALE"
10	Time trade off
11	Time trade-off
12	Timetradeoff
13	TTO
14	Standard Gamble
15	"SG" [Title/Abstract]
16	"Person tradeoff"
17	"Person trade-off"
18	PTO
19	preference based quality of life
20	"Health state utility value "
21	"Health state utilities value" [Title/Abstract]
22	"HSUV"
23	"Health state utility"
24	"Health state utilities"
25	"Health utility"
26	"Health utilities"
27	15-dimensional questionnaire
28	15D
29	"health utility index"
30	"Health utilities index"
31	HUI[Title/Abstract]
32	HUI1
33	HUI2
34	HUI3
35	OR ('1 to 34') AND COVID-19

Databases searched: PubMed: Epub Ahead of Print, In-Process &Other Non-Indexed Citations, 2020–2022

Date of search: 05/2022

QALY quality adjusted life years, *EQ-5D* EuroQol-5D, *SF-6D* Short Form-6D, *VAS* visual analog scale, *TTO* time-tradeoff, *SG* Standard Gamble, *PTO* Person trade off, *HSUV* Health state utility value, *15D* 15-dimensional questionnaire, *HUI* Health Utilities Index

limitations, to reflect the diverse impact of the pandemic worldwide. The search was limited to publications from 2020 to 2022 for several critical reasons. Firstly, the COVID-19 pandemic began in late 2019, with significant global spread occurring in early 2020. Limiting the search to this timeframe ensures that the studies included are directly relevant to the pandemic and its implications for HRQoL. Studies published during these years are more likely to focus on the unique health challenges and circumstances posed by COVID-19, thus providing the most current and applicable data. Secondly, the pandemic spurred an unprecedented surge in research activity. By focusing on publications from 2020 to 2022, this review captures the most recent and rapidly evolving body of knowledge. This period saw the development and dissemination of numerous studies specifically investigating the effects of COVID-19 on various health aspects, including HRQoL. This ensures the inclusion of the latest findings and emerging trends in the

field. Additionally, research conducted prior to 2020 would not encompass data related to the COVID-19 pandemic. Excluding earlier studies guarantees that all included research provides novel insights and findings related to the pandemic's impact, enhancing the relevance and specificity of the review's conclusions and recommendations. Moreover, healthcare policies and interventions have significantly evolved in response to emerging data on COVID-19. Studies from 2020 to 2022 reflect the latest understanding of the disease and its management, which is critical for providing evidence-based recommendations for healthcare providers, policymakers, and practitioners. Lastly, focusing on this specific timeframe ensures consistency in the data and context of the studies reviewed. This is crucial for making accurate comparisons and synthesizing findings across different studies, as the healthcare landscape and public health responses were relatively consistent during this period. Thus, this approach provides a comprehensive and relevant analysis of the pandemic's impact on HRQoL, ensuring that the findings are directly applicable to current healthcare challenges and policy needs. We applied inclusion and exclusion criteria to refine the search results, ensuring they were relevant and focused on our research objectives.

2.1.1 Inclusion and exclusion criteria

Articles were included in our review based on the following criteria: (a) reports presenting health state utility values (HSUVs) related to COVID-19 collected between 2020 and 2022; (b) publications in English in peer-reviewed journals; (c) presentation of original HSUVs data; and (d) use of direct or indirect methods to quantify HRQoL**.**

2.2 Study selection and data extraction

This literature review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, with the study selection process outlined in Fig. 1. The PRISMA flow diagram (Fig. 1) illustrates the selection process, with the initial search yielding 1,052 articles. After de-duplication and screening, 37 studies met the inclusion criteria. One reviewer (Xu) was responsible for the initial study selection, and a second reviewer (BV) checked the quality of the data. The search results were imported into Excel for de-duplication. At the title and abstract screening stage, an inclusive strategy was used to retrieve publications that met the inclusion criteria, including those whose eligibility was uncertain based on their title or abstract alone. These were then fully assessed on the basis of their full text. The selection process consisted of three steps: first, duplicates were removed using Excel; second, titles and abstracts were screened against the inclusion/exclusion criteria using a keyword search, with all excluded articles removed; third, all articles with uncertain eligibility were assessed in their full-text versions against the inclusion/exclusion criteria. An Excel form was prepared for data extraction from articles that passed the second stage.

A pre-designed Excel spreadsheet facilitated systematic data collection, recording key details from each eligible study, including (1) first author, year of publication; (2) country of research; (3) study title; (4) sample characteristics; (5) morbidity; (6) study design; (7) data collection method; (8) survey period; (9) HRQoL instrument(s) or utility measures (e.g., EQ-5D); (10) sample size; (11) health state description; and (12) mean health state utility (with standard deviation). All qualifying studies were identifiable after data compilation in Excel. We extracted directly reported utilities and, where necessary, converted utility scores from a scale of 0 to 100 to a scale of 0 to 1 for consistency. Numerical information was painstakingly extracted from graphical presentations where not directly reported in text or tables. Aggregated utility scores were systematically tabulated and summarized for analysis (Table 2 and Supplementary).

3 Results

3.1 Characteristics of included HRQoL studies

Our initial search of PubMed generated 1,052 articles focusing on the COVID-19 outbreak from 2020 to 2022. Through a detailed process of title and abstract screening, followed by full-text review (Fig. 1), we identified 37 studies [11–47] that met our inclusion criteria. These studies aimed to assess post-discharge persistent symptoms, rehabilitation needs, and HRQoL impacts among the general population, COVID-19 survivors, and specific disease groups. Of these, 31 were cross-sectional studies, four were cohort studies, one was a decision-making study, and one was a longitudinal study. The methodologies employed varied, including twenty studies that used online self-completed questionnaires, six with paper-based self-completed questionnaires, eight conducted via phone interviews (questionnaires), three through

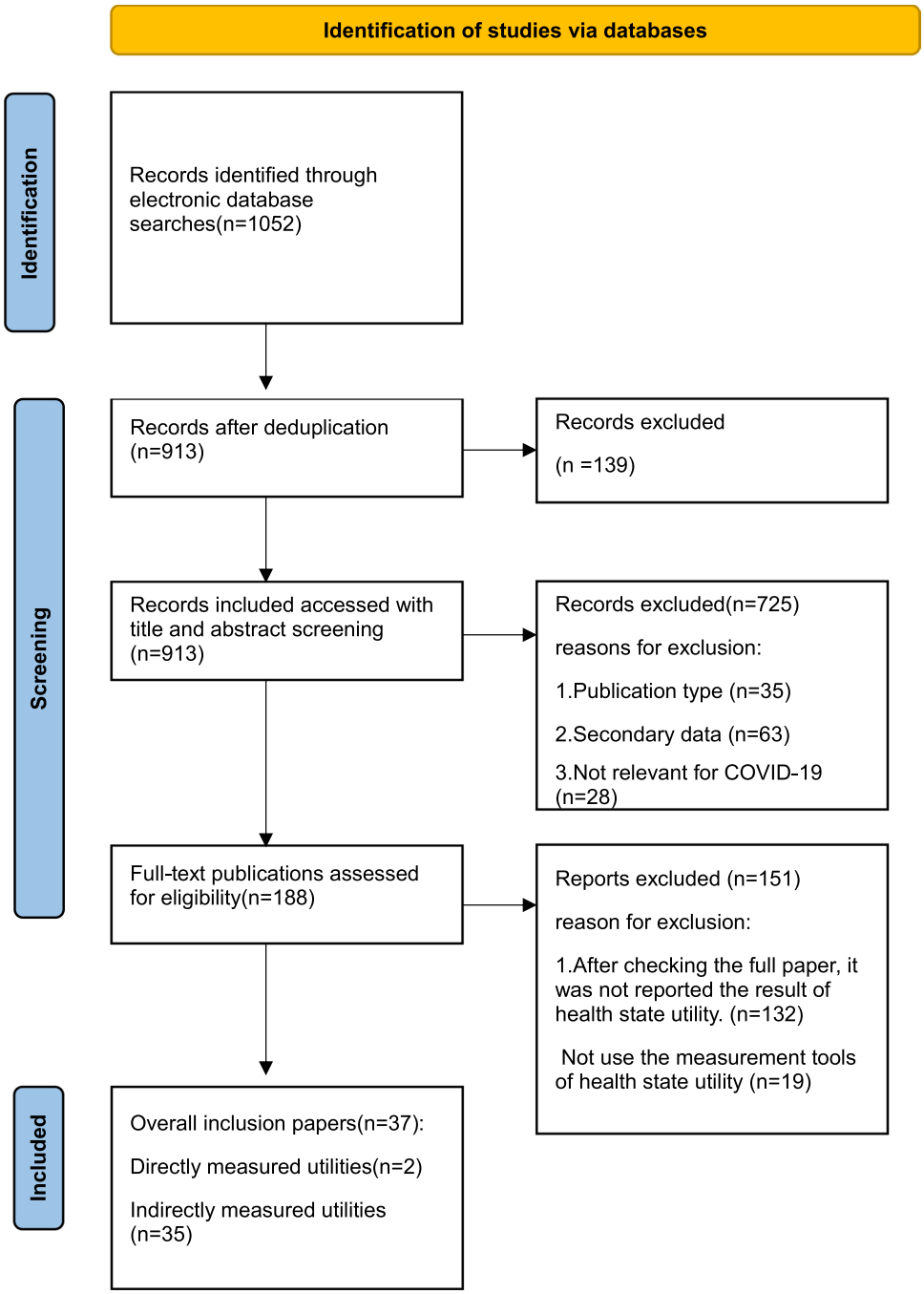

Fig. 1 Flow diagram for HRQoL. the number of records identified, included, and excluded at each stage of the review, and the reasons for exclusions

private interviews, and three that examined patients' healthcare records. These studies spanned five continents, including Europe (n = 20), North America (n = 4), Asia (n = 11), South America (n = 1), and Africa (n = 1), reflecting wide geographic diversity. The HRQoL instruments employed included 15D (n = 3), EQ-5D-5L (n = 24), EQ-5D-3L (n = 8), VAS (n = 1), and TTO (n = 1), covering a broad spectrum of health state utility measurements (Table 3).

A significant portion of the research focused on diverse populations, with sample sizes ranging from forty (Spain, Alzheimer's disease patients) to 15,037 (Germany, intellectual fitness of the general population). Specifically, 14 studies (representing 30.29% of the study population) addressed a broad population of COVID-19 infection cases, while seven studies (representing 5. 89% of the total population) focused on respondents with specific diseases, including Alzheimer's disease (AD) and amnesic mild cognitive impairment (MCI) [25], cardiovascular disease [26], skin disease [21], total hip (THA) or knee arthroplasty (KA) or partial knee arthroplasty (PKA) [32], cancer [31], bariatric surgery [15], and amyotrophic lateral sclerosis [20]. Each of these conditions was reported in single study (Table 3).

Table 2 Characteristics of the HRQoL literature included

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
1	Halpin et al	2020	UK	Adult patients were infected by COVID-19 within Leeds metropolitan district and discharged from LTHT hospital	Covid infection	05/2020–06/2020	EQ-5D-5L	100	–	–
2	Garrigues et al	2020	France	French speaking patients who were hospitalized in COVID-19 ward unit more than 100 days after their admission and discharged at the time of study	Covid infection	15/03/2020–14/04/2020	EQ-5D-5L	120	Overall	0.86
3	Ping et al	2020	China	Non-representative sample of the Changzhi city population	No	02/03/2020–10/03/2020	EQ-5D-3L	1139	Overall	0.949
4	Benítez et al	2020	Spain	Patients older than 60 diagnosed of amnesic mild cognitive impairment or mild AD were recruited from a single neurology center	No (Alzheimer's disease (AD) and amnesic mild cognitive impairment (MCI))	03/2020	EQ-5D-5L	40	Overall patients (Before the 5 weeks of lock down) (After the 5 weeks of lock down)	0.66 0.62
5	Vu et al	2020	Vietnam	Non-representative sample of Vietnam adult papulation	No	01/04/2020–30/05/2020	EQ-5D-5L	406	Overall	0.95
6	Arab-Zozani et al	2020	Iran	COVID-19 patients who had been discharged from the Shahid Sadoughi hospital	Covid infection	03/2020	EQ-5D-5L	409	Overall	0.6125

Table 2 (continued)

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
7	Azizi et al	2020	Morocco	Non-representative sample in Moroccan Arabic dialect during the home confinement period	No	09/05/2020–30/05/2020	EQ-5D-5L	573	Overall participants (Before confinement) (During confinement)	0.91 0.86
8	Lim et al	2020	Singapore	Age at least 21 years old adult Asian outpatients in National University Hospital of Singapore who were known with CVD and had completed a HRQoL questionnaire prior to the COVID-19 outbreak,	No (cardiovascular disease)	29/04/2020–19/06/2020	EQ-5D-3L	81	Overall (Pre-pandemic visit)	0.898
9	Meys et al	2020	Belgium, Netherlands	Flemish patients with confirmed/suspected COVID-19 were recruited from Belgian social support group on Facebook	Covid (or suspected) infection	06/06/2020	EQ-5D-5L	210	Overall	0.62
10	Ungureanu et al	2020	Romania	Resident or young specialist working in the gastroenterology department, recruited from 9 public hospitals of major university centers	No	21/04/2020–09/05/2020	15D	96	–	–
11	Than et al	2020	Vietnam	Frontline HCWs working at the NHTD and the Center for Tropical Diseases (CTD) of Bach Mai Hospital (BMH)	No	03/2020–04/2020	EQ-5D-5L	173	Overall	0.93

Table 2 (continued)

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
12	Guo et al	2020	China	Chinese patients with skin diseases during COVID-19	No (skin disease)	15/04/2020–27/04/2020	EQ-5D-3L	506	–	–
13	Ferreira et al	2020	Portugal	Non-representative sample of Portugal's adult population	No	03/2020–05/2020	EQ-5D-5L	904	Overall (Under COVID-19 Quarantine)	0.861
									(Pre-covid-19 Pandemic)	0.887
14	Hay et al	2020	the USA	non representative samples of Amazon MTurk workers in the USA	No	2020	EQ-5D-5L	2764	–	–
15	Alinia et al	2020	Iran	COVID-19 patients who were discharged from three hospitals over the past (research period) 2 weeks in Iran	Covid infection	21/05/2020–18/06/2020	TTO	287	Overall	0.863
16	van Rüth et al	2020	Germany	Homeless persons of Hamburg in specialized medical practices or lodging houses,	No	25/05/2020–03/06/2020	EQ-5D-5L	111	Overall (Homeless people)	0.84
17	Gamberini et al	2020	Italy, Finland	Adults' patients from 16 Italian ICUs infected with COVID-19 due to respiratory failure and the need for invasive mechanical ventilation during ICU stay	Covid infection	22/02/2020–04/05/2020	15D	205	Overall (Study population)	0.85

Table 2 (continued)

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
18	Turcu-Stiolica et al	2020	Romania, Bulgaria	Pharmacists working in community pharmacies who were with possible contacted with COVID-19 patients from Romania and Bulgaria	No	15/07/2020–15/08/2020	15D	395	Overall (Romania)	0.956
19	Clement et al	2020	UK	Ten orthopedic departments in the UK of patients on the NHS waiting lists for either a total hip (THA) or total (TKA) or partial knee arthroplasty (PKA) during the months of August and September 2020	No (Total hip (THA) or knee arthroplasty (KA)or partial knee arthroplasty (PKA))	08/2020–09/2020	EQ-5D-5L	843	–	–
20	Bäuerle et al	2020	Germany	Non-representative sample of the German adult population	No	10/03/2020–05/05/2020	EQ-5D-3L	15037	Overall (Before COVID-19 outbreak)	0.8232
21	Szabó et al	2020	Hungary	non representative sample inside the three public online groups of Hungary adult population	No	07/05/2020–20/05/2020	VAS	431	Overall (Before eliminated the significant outliers)	0.731
									(After eliminated the significant outliers)	0.751
22	Musche et al	2020	Germany	Adults' cancer patients of the University Hospital Essen	No (Cancer)	16/03/2020–31/03/2020	EQ-5D-3L	300	Overall (Cancer patients)	0.6605
									(Healthy controls)	0.7899
23	Beisani et al	2020	Spain	Patients in the bariatric surgery waiting list of an institution before Lockdown	No (Bariatric surgery)	05/05/2020–10/05/2020	EQ-5D-5L	51	Overall (Self-rated health index (before LD))	0.69

Table 2 (continued)

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
									(Self-rated health index (After LD))	0.64
24	Walle-Hansen et al	2020	Norway	Covid-19 patients aged over 60 years that were still alive 180 days after hospital admission	Covid infection	01/03/2020–01/07/2020	EQ-5D-5L	106	Overall (Before admission) (After six months)	0.77 0.658
25	Greenhawt et al	2020	the USA	Non-representative sample of the USA adult population	No	04/25/2020–06/05/2020	EQ-5D-3L	4855	Overall (Surveyed population) (Normative population total)	0.714 0.8
26	Navarro et al	2020	Mexico	Patients infected by COVID-19 from a single hospital in Mexico	Covid infection	01/04/2020–30/07/2020	EQ-5D-5L	115	Overall (Pre-COVID-19) (After COVID-19)	0.95 0.85
27	Machado et al	2020	Netherlands, Belgium	Participants who recovered from COVID-19 that from two Facebook groups also who were registered at a website of the Lung Foundation Netherlands	Covid infection	04/06/2020–11/06/2020	EQ-5D-5L	1939	–	–
28	Todt et al	2020	Brazil	Adults' patients infected by COVID-19 and survived to hospital discharge	Covid infection	16/03/2020–08/05/2020	EQ-5D-3L	251	Overall (3 months following discharge) (Before the onset of COVID-19 symptoms)	0.8012 1
29	Iqbal et al	2020	Pakistan	Adult patients from Laboratory recovered from COVID-19	Covid infection	09/2020–12/2020	EQ-5D-5L	158	Overall	0.7076
30	Giusiano et al	2021	Italy	ALS patients were at the Turin ALS Center and were scheduled from 1st March 2020 to 1st April 2020	No (Amyotrophic lateral sclerosis)	04/2020	EQ-5D-5L	119	–	–

Table 2 (continued)

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
31	Douglas	2021	UK	HCWs in a university neurosciences center	No	02/05/2020–07/06/2020	EQ-5D-3L	215	Total	0.821
32	Zhou et al	2022	Portland	women at each gestational age between 24 and 32weeks who were hospitalized with PPROM and found to be COVID-19 positive	Covid infection	NR	EQ-5D-5L	10,000	–	–
33	Xu et al	2022	China	non representative Chinese adult	No	20/02/2020 -12/03/2020	EQ-5D-5L	1245	Overall	0.91
34	Wong et al	2022	China	employees in workplace in Hong Kong, China	No	17/02/2020 -27/02/2020	EQ-5D-5L	1048	Overall	0.897
35	Şahan et al	2022	the USA	Patients with a history of COVID-19 diagnosis and persistent OD were recruited from a tertiary medical center and a social media support forum for chemosensory dysfunction	Covid infection (COVID-19 olfactory dysfunction (OD))	06/2020 and 04/2021	EQ-5D-5L	286	Overall	0.809
36	Russo et al	2022	Spanish	non representative participants from Madrid	Covid infection	16/02/2021 and 16/04/2021	EQ-5D-5L	125	Overall	0.799
37	Ohsfeldt et al	2022	Japan	The participants were over 65 years of age and lived in Kakeya, Matsukasa, Tane, or Tai	No	02/2021 and 02/2022	EQ-5D-5L	38,882	–	–

Table 3 Summary of the heterogeneity in the design of HRQoL literature

Study characteristics	Summary
Geographical location	Europe n = 20, North America n = 4, Asia n = 11, South America n = 1, Africa n = 1
COVID-19 infection	All participants infected n = 13, Participants partly infected n = 1, Post COVID patients n = 7, Not reported n = 16
Morbidity	No specific disease n = 16, COVID-19 infection n = 14, Alzheimer's disease (AD) and amnesic mild cognitive impairment (MCI) n = 1, Cardiovascular disease n = 1, Skin disease n = 1, Total hip (THA) or knee arthroplasty (KA) or partial knee arthroplasty (PKA) n = 1, Cancer n = 1, Bariatric surgery n = 1, Amyotrophic lateral sclerosis n = 1
Study setting	Cross-sectional n = 31, Retrospective cohort n = 1, Prospective cohort n = 1, Cohort study n = 2, Decision-analytic model n = 1, Longitudinal design n = 1
Data collection method	Online questionnaire n = 20, Paper questionnaire n = 6, Telephone interview(questionnaire) n = 8, Personal interview n = 3, Patient's medical records n = 3 Some of the publication used more than one data collection method
Utility measurement	Direct n = 2, Indirect n = 35
Tools for direct / indirect utility measurement	VAS n = 1, TTO n = 1, EQ-5D-3L n = 8, EQ-5D-5L n = 24, 15D n = 3

3.2 HRQoL based on EQ-5D dimension responses

Within the review, a total of sixteen out of 37 studies used the EQ-5D instrument for HRQoL domains assessment. Twelve studies utilized the EQ-5D-5L instrument, known for its validity and reliability across five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, to report HRQoL domain performance. Each dimension in the EQ-5D-5L has five levels: no problems, slight problems, moderate problems, severe problems, and extreme problems. The EQ-5D-3L, like the EQ-5D-5L, assesses the same dimensions but with three levels: no problems, some problems, and extreme problems. In this review, four studies used the EQ-5D-3L instrument to assess HRQoL domain performance.

Analysis of the studies using the EQ-5D instrument identified that the self-care domain (14 studies) was consistently reported as the least affected HRQoL domain, with only two studies indicating usual activities as the least

affected domain. Conversely, the anxiety/depression domain was identified as the most affected HRQoL domain in eight studies, followed closely by the pain/discomfort domain in seven studies. Mobility and usual activities were also noted as significantly impacted domains. These findings underscore the varied impact of COVID-19 on different HRQoL domains. Detailed outcomes for each HRQoL domain assessment are cataloged in Table 4.

3.3 Analyzing HRQoL utility variations across COVID-19 infection and demographics of selected literature

From the data of 46,709 respondents, we determined 274 health state utility values (HSUVs). Notably, four studies [14, 17, 26, 34] provided comprehensive utilities before and after the COVID-19 pandemic, with HSUVs ranging from 0.823 to 0.95 before the pandemic and 0.802 to 0.861 after. Furthermore, HSUV data were richly detailed across studies, including six studies focusing on population norms [11, 13, 21, 23, 35, 42]. Two articles reported the HSUVs of caregivers before and after lockdown (0.29 to 0.74; 0.31 to 0.72, respectively) and the patients (with HSUVs ranging from 0.5 to 0.66 and 0.6 to 0.62, respectively) [15, 20]. Three studies reported the utility of ICU and ward participants during hospitalization with HSUVs ranging from 0.581 to 0.82, and from 0.72 to 0.86, respectively) [12, 19, 22]. Three studies reported HSUVs in quarantined individuals [13, 21, 43], with HSUVs ranging from 0.86 to 0.96. These findings, collectively summarized in Table 5, underscore the extensive HRQoL challenges posed by the pandemic and highlight the diverse methodologies and populations involved in the current body of research (Table 2).

The pandemic's uniform risk of infection contrasted with the varying HSUVs observed across different timeframes, locations and geographies. Before the outbreak, higher HSUVs were consistently reported. For example, in Germany, respondents reported a utility of 0.823 before COVID-19, which decreased to 0.803 after the pandemic [14]. Similarly, in Mexico, respondents' utility was 0.95 before the pandemic and 0.85 after the pandemic [34]. Similar trends were noted in Morocco and Portugal, with pre-restriction HSUVs at 0.91 and 0.887 dropping to 0.86 and 0.861 post-restriction [13, 17]. Young specialists working in the gastroenterology department of designated COVID-19 hospitals were found to have lower utility values than their counterparts. In Romania, the utility of individuals in designated hospitals was 0.957, compared to 0.966 for those working in non-COVID-19 hospitals [41]. Similarly, in Vietnam, the utility of participants in designated hospitals was 0.87 compared with 0.93 for non-designated hospitals [28]. Additionally, examining HSUVs in individuals with and without prior COVID-19 infections revealed nuanced insights into the pandemic's impact on HRQoL across different geographies. Iran reported the highest overall HSUV among those previously infected, with a value of 0.863 [11]. Conversely, the lowest HSUV, at 0.51, was noted in Belgium and the Netherlands among infected individuals with coexisting health conditions [30] (Table 2 and Supplementary).

Table 4 EO-5D dimensions of HRQoL assessment

First author last name	Year of publication	Most affected dimension	Least affected dimension
Halpin et al	2020	ICU: Usual activities, Ward: Mobility	ICU + Ward: Self-care
Ping et al	2020	Pain/discomfort	Self-care
Vu et al	2020	Anxiety/depression	Self-care
Arab-Zozani et al	2020	Mobility	Self-care
Azizi et al	2020	ICU: Pain/discomfort Ward: Anxiety/depression	ICU + Ward: Self-care
Lim et al	2020	Anxiety/depression	Self-care
Meys et al	2020	Pain/discomfort	Self-care
Than et al	2020	Anxiety/depression	Self-care
Ferreira et al	2020	Anxiety /depression	Self-care
van Rüth et al	2020	Pain/discomfort	Self-care
Beisani et al	2020	Anxiety/depression	Self-care
Greenhawt et al	2020	Anxiety/depression	Self-care
Navarro et al	2020	Pain/discomfort	Self-care
Todt et al	2020	Pain/discomfort	Self-care
Iqbal et al	2020	Pain/discomfort	Usual activities
Wong, E. L et al	2022	Anxiety/depression	Usual activities

Table 5 Key factors contributing to Low HRQoL in selected literature

Author	Year of publication	Factors of low HRQoL detail
Ping et al	2020	Older age, Unemployed, with chronic disease, low family income, worry about got COVID-19, and have epidemic effects
Vu et al	2020	Higher ages, females, and living with chronic diseases, working individuals having to be under self-isolation or in government quarantine facilities
Arab-Zozani et al	2020	Female gender, older age, higher education level, being unemployed, ICU admission, and having diabetes
Than et al	2020	≥ 30 years old, had higher working years, had higher incomes, and had mental health and sleep problems, suffered from mental health problems, and sleeping disorders symptoms
Guo et al	2020	Outdoor activity restriction, loss of income, unemployment
Ferreira et al	2020	Women, older age categories, low levels of education, single individuals, individuals with chronic diseases
Hay et al	2020	"Other" gendered persons, Asian, American Indian, or Alaska Native race, Hispanic ethnicity, single, annual incomes less than $20,000, Living alone, experiencing COVID-19-like symptoms not requiring hospitalization, and having a family member diagnosed with COVID-19, self-reported fear of COVID-19's impact on personal health
van Rüth et al	2020	Higher age and lower education levels
Gamberini et al	2020	Female sex, increasing age, number of comorbidities, ARDS class, duration of mechanical ventilation, and inability to return to work
Clement et al	2020	Each additional month spent on the waiting list, and each additional six months on the waiting list patients, younger age, female sex, patients waiting for a THA
Szabó et al	2020	Perceived stress, level of anxiety, level of depression, number of neurotic complaints, and emotion-focused coping
Walle-Hansen et al	2020	Older age
Todt et al	2020	Female sex and intensive care requirement
Xu, Z et al	2022	living alone
Wong, E et al	2022	Lack of workplace policies, lack of protective equipment supplies and dissatisfied with workplace policies
Şahan, S et al	2022	Women, reported having fatigue, shortness of breath, "brain fog"/confusion, and muscle ache/joint pain, a history of depression and anxiety, sought medical care for their chemosensory dysfunction, belonging to a social media support group for OD, seeing an MD for OD, a history of chronic pain, and depression/anxiety

Among the 37 included studies, 16 identified various determinants associated with diminished HRQoL during COVID-19. Notably, eight studies reported that older individuals tend to experience lower HRQoL levels. Similarly, seven studies identified a correlation between female gender and reduced HRQoL. COVID-19-related factors, such as history of infection, quarantine status, ICU admission, prolonged mechanical ventilation, or longer ICU stay, were linked to decreased HRQoL in five studies. Furthermore, seven studies demonstrated that individuals with comorbidities reported lower HRQoL compared to those without, indicating the compounded impact of additional health challenges. The detailed associations between these factors and HRQoL are systematically presented in Table 5.

4 Quality assessment of selected studies of HRQoL literature

To evaluate the quality of the studies included in this HRQoL literature review, we utilized three specific tools: the Appraisal Tool for Cross-Sectional Studies (AXIS) (N = 31) [48], Newcastle–Ottawa Scale (NOS) (N = 5) [49], and Consolidated Health Economic Evaluation Reporting Standards (CHEERS) (N = 1) [50] for cross-sectional studies, cohort studies, and decision-analytic model, respectively.

The AXIS tool assesses various aspects of study quality, including clarity of objectives, appropriateness of study design, sample size justification, representativeness of the sample, measurement validity, and consideration of potential biases. The NOS tool evaluates studies based on three domains: selection, comparability, and outcome, with a maximum of nine stars indicating the highest quality. Studies were assessed on the representativeness of the sample, ascertainment of exposure, demonstration that the outcome of interest was not present at the start of the study, comparability of cohorts, and assessment of outcome and adequacy of follow-up. Each domain was rated, and disagreements were resolved through consensus or consultation with a third reviewer. This rigorous process ensured a comprehensive and reliable assessment of the included studies' quality. The CHEERS tool was utilized for assessing the quality of health economic evaluations. It ensures that studies adhere to standardized reporting practices, evaluating aspects such as the transparency of the economic evaluation, the methodology used, the presentation of results, and the discussion of study limitations. By using the CHEERS tool, we ensured that the health economic evaluations included in our review met high standards of reporting quality and reliability.

The quality of the 31 cross-sectional studies included was evaluated using the AXIS tool, with responses recorded as "Yes" or "No" for specific criteria (Table 6). Our analysis revealed that all 31 studies had clear study objectives and employed appropriate cross-sectional methodologies. Five studies [14, 23, 24, 27, 40] reported justified sample size estimations. All studies clearly defined the reference population and sample frame, ensuring representativeness. Except for one study [22], all studies tested both the validity and reliability of their questionnaires. Regarding the reporting of survey results, most studies presented adequate basic data and addressed concerns about non-response bias, with fifteen studies reporting information about non-responders [12–14, 19, 22, 25, 27, 30, 31, 35, 38, 39, 43, 45, 46]. The results were internally consistent, and the analyses described were presented. Discussions and conclusions were justified in all studies, and limitations were transparently discussed. Most studies declared no conflicts of interest, with a few exceptions [30, 41]. Ethical approval or consent was obtained in all studies. Overall, the evaluated studies met most key criteria for rigorous research. Areas for improvement included sample size justification and detailed information about non-responders. The consistent use of validated instruments and clear descriptions of target populations and methods were strengths across most studies. Discussions and conclusions were typically well-justified, and limitations were acknowledged, contributing to transparency and reliability. The quality assessment reveals a generally high level of methodological rigor despite some limitations, providing valuable insights into the diverse effects of the pandemic on different populations and significantly contributing to our understanding of HRQoL during COVID-19.

The quality of five included studies was assessed using the NOS (N = 5) tool, which evaluates studies based on three domains: selection, comparability, and outcome, with a maximum of nine stars indicating the highest quality (Table 7). All studies effectively selected their exposed cohorts, ensuring the representation of their specific populations [18, 26, 39, 44]. Only Ryuichi Ohta and Lorenzo Gamberini [18, 33] included non-exposed cohorts for comparison. All studies confirmed COVID-19 diagnosis and health outcomes through medical records or validated questionnaires like EQ-5D, ensuring that the outcome of interest was not present at the start of the study, thereby clarifying baseline health status. In terms of comparability, all studies adjusted for key covariates such as age, sex, and other relevant factors, enhancing the reliability of their findings [18, 26, 33, 39, 44], and received two stars for comparability, indicating robust adjustment methods. The follow-up periods ranged from three months to one year, ensuring sufficient time to observe outcomes, with high follow-up rates and clear documentation of missing data. Outcomes were assessed using validated instruments

Table 6 Study quality of selected HRQoL studies

Author/ Criteria	Stephen J. Halpin et al	Eve Garrigues et al	Weiwei Ping et al	Beatriz Lara, B et al	Zijun Xu et al	Eliza Lai-Yi Wong et al	Mena Said MD et al	Cristina Sacrista´n-Galiste et al.o	Alexander Bäuerle et al	Mai Quynh Vu et al	Morteza Arab-Zozani et al	Asmaa Azizi et al	Csanád Szabó et al	Venja Musche et al	Roy Meys et al	Marc Beisani et al
Introduction																
1. Clear aims/ objectives	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Methods																
2. Appropriate study design	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Sample size justified	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No
4. Target population clearly defined	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Sample frame appropriate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Representative selection process	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. Measures for non-responders	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
8. Appropriate risk factor and outcome variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9. Correct measurement using validated instruments	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10. Clear statistical significance/ precision estimates	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6 (continued)

Author/ Criteria	Stephen J. Halpin et al	Eve Garrigues et al	Weiwei Ping et al	Beatriz Lara, B et al	Zijun Xu et al	Eliza Lai-Yi Wong et al	Mena Said MD et al	Cristina Sacrista´n-Galiste et al.o	Alexander Bäuerle et al	Mai Quynh Vu et al	Morteza Arab-Zozani et al	Asmaa Azizi et al	Csanád Szabó et al	Venja Musche et al	Roy Meys et al	Marc Beisani et al
11. Sufficiently described methods	Partially	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Results																
12. Adequately described basic data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13. Concerns about non-response bias	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14. Information about non-responders	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
15. Internally consistent results	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16. Results for analyses described in methods presented	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Discussion																
17. Justified discussions and conclusions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18. Limitations discussed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other																
19. Funding sources/ conflicts of interest	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	Yes (conflict of interest noted)	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	Yes	No conflicts of interest declared

Table 6 (continued)

Author/ Criteria	Stephen J. Halpin et al	Eve Garrigues et al	Weiwei Ping et al	Beatriz Lara, B et al	Zijun Xu et al	Eliza Lai-Yi Wong et al	Mena Said MD et al	Cristina Sacrista´n-Galiste et al.o	Alexander Bäuerle et al	Mai Quynh Vu et al	Morteza Arab-Zozani et al	Asmaa Azizi et al	Csanád Szabó et al	Venja Musche et al	Roy Meys et al	Marc Beisani et al
20. Ethical approval or consent attained	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Bogdan Silviu Ungureanu et al	Hung Manh Than et al	Yeye Guo et al	Lara N. Ferreira et al	Joel W. Hay et al	Cyrus Alinia et al	M. M. Walle-Hansen et al	Matthew Greenhawt et al	V. van Rüth et al	Felipe V. C. Machado et al	Ayman Iqbal et al	Adina Turcu-Stiolica et al	Silvia Giusiano et al	N. D. Clement et al	Deborah R. Douglas et al	
Introduction																
1. Clear aims/ objectives	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Methods																
2. Appropriate study design	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
3. Sample size justified	No	No	No	No	Yes	No	No	No	No	No	Yes	Yes	No	Yes	Yes	
4. Target population clearly defined	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
5. Sample frame appropriate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
6. Representative selection process	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
7. Measures for non-responders	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	

Table 6 (continued)

	Bogdan Silviu Ungureanu et al	Hung Manh Than et al	Yeye Guo et al	Lara N. Ferreira et al	Joel W. Hay et al	Cyrus Alinia et al	M. M. Walle-Hansen et al	Matthew Greenhawt et al	V. van Rüth et al	Felipe V. C. Machado et al	Ayman Iqbal et al	Adina Turcu-Stiolica et al	Silvia Giusiano et al	N. D. Clement et al	Deborah R. Douglas et al
8. Appropriate risk factor and outcome variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9. Correct measurement using validated instruments	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10. Clear statistical significance/precision estimates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11. Sufficiently described methods	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Results															
12. Adequately described basic data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13. Concerns about non-response bias	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14. Information about non-responders	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Table 6 (continued)

	Bogdan Silviu Ungureanu et al	Hung Manh Than et al	Yeye Guo et al	Lara N. Ferreira et al	Joel W. Hay et al	Cyrus Alinia et al	M. M. Walle-Hansen et al	Matthew Greenhawt et al	V. van Rüth et al	Felipe V. C. Machado et al	Ayman Iqbal et al	Adina Turcu-Stiolica et al	Silvia Giusiano et al	N. D. Clement et al	Deborah R. Douglas et al
15. Internally consistent results	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16. Results for analyses described in methods presented	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Discussion															
17. Justified discussions and conclusions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18. Limitations discussed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other															
19. Funding sources/conflicts of interest	Yes	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared
20. Ethical approval or consent attained	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 7 Newcastle–Ottawa Scale (NOS) for cohort study of selected HRQoL studies

Ryuichi Ohta et al			M. M. W Hansen et al			Beatriz Costa Todt et al			Shir Lynn Lim et al			Lorenzo Gamberini et al		
Criteria	Assessment	S	Criteria	Assessment	S	Criteria	Assessment	S	Criteria	Assessment	S	Criteria	Assessment	Stars
Selection			Selection			Selection			Selection			Selection		
1. Representativeness of the exposed cohort	Selected group of rural older people over 65 years old, high aging rate but specific demographic focus	★	1. Representativeness of the exposed cohort	Patients aged 60 and older hospitalized due to COVID-19, covers a broad age range	★	1. Representativeness of the exposed cohort	Likely includes survivors of COVID-19, representative of this group	★	1. Representativeness of the exposed cohort	Patients with CVD from a large tertiary hospital, representing a multiethnic Asian population	★	1. Representativeness of the exposed cohort	Critically ill COVID-19 patients from multiple Italian ICUs, representative of the severely affected population	★
2. Selection of the non-exposed cohort	Drawn from the same community as the exposed cohort	★	2. Selection of the non-exposed cohort	No separate non-exposed cohort, all participants had COVID-19		2. Selection of the non-exposed cohort	No separate non-exposed cohort, all participants are COVID-19 survivors		2. Selection of the non-exposed cohort	Not applicable, as there is no non-exposed cohort		2. Selection of the non-exposed cohort	Age and sex-matched Italian and Finnish general populations as reference groups	★
3. Ascertainment of exposure	Self-reported questionnaire on self-management preferences	★	3. Ascertainment of exposure	Hospital records confirming COVID-19 diagnosis	★	3. Ascertainment of exposure	Confirmed COVID-19 diagnosis via medical records	★	3. Ascertainment of exposure	HRQoL assessed using validated EQ-5D questionnaire	★	3. Ascertainment of exposure	COVID-19 diagnosis and ICU admission confirmed by medical records	★
4. Demonstration that outcome of interest was not present at start of study	Excluded participants who preferred self-management at baseline	★	4. Demonstration that outcome of interest was not present at start of study	Assessed pre-COVID-19 health retrospectively at follow-up	★	4. Demonstration that outcome of interest was not present at start of study	Outcomes (clinical and QOL measures) were assessed post-COVID-19	★	4. Demonstration that outcome of interest was not present at start of study	Baseline HRQoL assessment prior to the pandemic	★	4. Demonstration that outcome of interest was not present at start of study	Assessed HRQoL post-ICU discharge, ensuring baseline was pre-discharge	★
Comparability			Comparability			Comparability			Comparability			Comparability		

Table 7 (continued)

Ryuichi Ohta et al			M. M. W Hansen et al			Beatriz Costa Todt et al			Shir Lynn Lim et al			Lorenzo Gamberini et al		
1. Comparability of cohorts on the basis of the design or analysis	Adjusted for key covariates such as age, sex, socio-economic status	★★	1. Comparability of cohorts on the basis of the design or analysis	Adjusted for age and disease severity	★★	1. Comparability of cohorts on the basis of the design or analysis	Likely adjusted for key variables such as age and baseline health status	★★	1. Comparability of cohorts on the basis of the design or analysis	Adjusted for sociodemographic and clinical factors	★★	1. Comparability of cohorts on the basis of the design or analysis	Adjusted for age, sex, comorbidities, ARDS class, and duration of mechanical ventilation	★★
Outcome			Outcome			Outcome			Outcome			Outcome		
1. Assessment of outcome	Used validated EQ-5D-5L to measure QOL	★	1. Assessment of outcome	Used validated EQ-5D-5L to measure HR-QoL and functional status	★	1. Assessment of outcome	Used validated tools for QOL and clinical outcomes assessment	★	1. Assessment of outcome	Used validated EQ-5D instrument for HRQoL assessment	★	1. Assessment of outcome	Used validated 15D instrument for HRQoL assessment	★
2. Was follow-up long enough for outcomes to occur	One year follow-up period	★	2. Was follow-up long enough for outcomes to occur	Six-month follow-up period	★	2. Was follow-up long enough for outcomes to occur	Follow-up period appropriate for observing long-term effects	★	2. Was follow-up long enough for outcomes to occur	Follow-up during the pandemic	★	2. Was follow-up long enough for outcomes to occur	90-day follow-up period post-ICU discharge	★
3. Adequacy of follow-up of cohorts	High follow-up rate with clear documentation of missing data	★	3. Adequacy of follow-up of cohorts	High follow-up rate with clear documentation of those lost to follow-up	★	3. Adequacy of follow-up of cohorts	Likely documented follow-up procedures and rates	★	3. Adequacy of follow-up of cohorts	High follow-up rate, with detailed documentation of assessments	★	3. Adequacy of follow-up of cohorts	Adequate follow-up with detailed documentation of respondent and non-respondent characteristics	★
Total Stars		8	Total Stars		7	Total Stars		7	Total Stars		8	Total Stars		9

such as the EQ-5D-5L and 15D, ensuring consistent and reliable measurement of HRQoL. Ryuichi Ohta and Shir Lynn Lim [26, 33] received eight stars each, indicating high-quality studies with comprehensive selection, comparability, and outcome assessment. M. M. Walle-Hansen and Beatriz Costa Todt [39, 44] received seven stars each, reflecting strong methodologies but lacking a non-exposed cohort. Lorenzo Gamberini [18] received nine stars, indicating a very high-quality study with thorough selection and robust follow-up procedures. Collectively, these studies highlight the importance of clear cohort selection, adjustment for key variables, and the use of validated tools in assessing the impact of COVID-19 on HRQoL, underscoring the diverse impacts of COVID-19 across different populations.

One selected study [36] was assessed using the CHEERS tool and received high marks in all areas. The title, abstract, background, and objectives were clear, with well-defined populations and settings. The methods were robust, using validated tools, and findings were well-discussed. Overall, the study adhered to CHEERS guidelines, indicating high quality (Table 8).

5 Discussion

This systematic review aimed to explore the relationship between demographic, socio-economic, and COVID-19-related characteristics and HRQoL during the pandemic. The review provides a comprehensive overview of how COVID-19 infection, severity of infection, quarantine measures, vaccination status, and socio-demographic factors influenced HRQoL, along with the performance of the EQ-5D domains in assessing these impacts.

The reviewed studies collectively highlight the extensive and persistent symptoms experienced by COVID-19 survivors. COVID-19 infection, particularly with severe symptoms, significantly decreased the HRQoL of participants, emphasizing the need for comprehensive post-recovery rehabilitation programs. For example, a study conducted in Leeds, UK, involving 100 survivors assessed 4 to 8 weeks post-discharge, found fatigue to be the most prevalent symptom, affecting 72% of ICU patients and 60.3% of ward patients. Breathlessness was also significant, reported by 65.6% of ICU patients and 42.6% of ward patients. Psychological distress was common, with 46.9% of ICU patients and 23.5% of ward patients affected. These patients showed a clinically significant drop in EQ-5D-5L scores, indicating a considerable decline in their HRQoL [22]. Similarly, a study from France involving 279 hospitalized COVID-19 patients found that even after a mean of 110.9 days post-admission, fatigue (55%) and dyspnea (42%) were prevalent. Memory loss (34%) and concentration issues (28%) were also notable. The study utilized the EQ-5D-5L questionnaire to assess HRQoL and found that despite these persistent symptoms, the overall HRQoL scores were relatively satisfactory, though patients required ongoing follow-up and rehabilitation [19]. In Mexico, a follow-up study of 115 patients at least 30 days post-COVID-19 revealed a severe decrease in HRQoL in 56% of patients, with 63% experiencing persistent symptoms. The study highlighted alterations in usual activities and anxiety/depression, with restrictive lung impairment being the most common spirometric alteration found in 17% of the patients. This was particularly significant even in those with mild COVID-19, emphasizing the long-term respiratory impact of the virus [34]. Mena Said et al. focused on persistent olfactory dysfunction (OD) related to COVID-19, finding that 89.16% of participants reported parosmia, which significantly affected their health utility values (HUVs) [37]. Cristina Sacristán-Galisteo et al. validated the Spanish version of the Post-COVID-19 Functional Status (PCFS) scale, finding it reliable for assessing functional status and recovery in COVID-19 survivors. This tool showed strong correlations with HRQoL measures and highlighted the importance of continuous monitoring of functional status post-recovery [36]. A study by Morteza Arab-Zozani et al. in Iran highlighted that the mean EQ-5D-5L score for COVID-19 patients was low, indicating poor HRQoL [13]. Finally, the study by Iqbal et al. from Pakistan emphasized the long-term effects of COVID-19, noting that a significant proportion of survivors experienced persistent symptoms such as fatigue and dyspnea, necessitating comprehensive rehabilitation strategies to improve their HRQoL [24].

Studies reported that quarantine and isolation measures, while necessary to control the spread of the virus, had a notable negative impact on HRQoL. Increased levels of anxiety, depression, and stress were observed among quarantined individuals, leading to lower HRQoL scores [13, 14, 35]. Quarantine measures and isolation further contributed to the decline in HRQoL, as noted by Arab-Zozani et al. [12]. The mental health burden of being isolated, the disruption of daily routines, and the uncertainty about health outcomes can significantly diminish HRQoL. The restrictions imposed during quarantine can lead to reduced physical activity, altered eating habits, and changes in sleep patterns, all of which negatively affect physical and mental well-being. Vaccination status is another critical factor influencing HRQoL. Unvaccinated individuals reported lower HRQoL due to ongoing health concerns and heightened anxiety about contracting the virus, as observed by Alinia et al., Zhang et al., and Ferreira et al. [11, 17, 46]. The sense of vulnerability and fear of severe illness among unvaccinated individuals can lead to increased stress and anxiety, further reducing HRQoL. In contrast,

Table 8 Study quality assessment using CHEERS tool for selected HRQoL studies

Clarice G. Zhou et al	
1. Title	Yes. The title clearly identifies the study as a decision analysis regarding antenatal corticosteroids
2. Abstract	Yes. The abstract is structured and includes the objectives, methods, results, and conclusions
Introduction	
3. Background and Objectives	Yes. The introduction provides context about the use of corticosteroids and the need to evaluate their use in the context of COVID-19
Methods	
4. Target Population and Subgroups	Yes. The study describes a theoretical cohort of 10,000 women at each gestational age between 24 and 32 weeks with COVID-19 and PPROM
5. Setting and Location	No. The setting and specific geographic location are not explicitly mentioned, but it is implied that the context is clinical settings where women with PPROM and COVID-19 are treated
6. Study Perspective	Yes. The study uses a healthcare perspective, focusing on maternal and infant outcomes and QALYs
7. Comparators	Yes. The study compares antenatal corticosteroid administration versus no corticosteroid administration
8. Time Horizon	Yes. The time horizon is the period between 24 and 32 weeks of gestation, focusing on short-term outcomes of maternal and infant health
9. Discount Rate	No. The study does not mention the application of discount rates, which might be less relevant due to the short time horizon
10. Choice of Health Outcomes	Yes. The primary outcomes include QALYs, ICU admissions, maternal and infant deaths, respiratory distress syndrome, intraventricular hemorrhage, and neurodevelopmental delay
11. Measurement of Effectiveness	Yes. Effectiveness data are derived from existing literature and clinical data on the outcomes of corticosteroid use and COVID-19 complications
12. Measurement and Valuation of Preference-Based Outcomes	Yes. QALYs are used to measure and value health outcomes, and the methodology for these is explained
13. Estimation of Resources and Costs	No. There is no detailed explanation of the cost estimation or resource use, focusing primarily on health outcomes
14. Currency, Price Date, and Conversion	No. The study does not mention currency, price date, or conversions, as it focuses on theoretical outcomes rather than specific costs
15. Analytic Methods	Yes. The study uses deterministic and probabilistic sensitivity analyses to evaluate model assumptions
Results	
16. Study Parameters	Yes. Key parameters include ICU admissions, maternal and infant deaths, respiratory distress syndrome, intraventricular hemorrhage, neurodevelopmental delay, and QALYs
17. Incremental Costs and Outcomes	No. The study focuses on outcomes but does not report incremental costs, which are typical in health economic evaluations
18. Characterizing Uncertainty	Yes. Uncertainty is addressed through sensitivity analyses
19. Characterizing Heterogeneity	No. The study does not provide a detailed discussion of heterogeneity across different subgroups beyond gestational ages
Discussion	
20. Study Findings, Limitations, Generalizability, and Current Knowledge	Yes. The discussion interprets the findings, acknowledges limitations, and places the results in the context of existing knowledge
Other	
21. Source of Funding	No. The source of funding is not mentioned
22. Conflicts of Interest	No. There is no mention of conflicts of interest
23. Ethical Approval	No. As this is a decision-analytic model study, ethical approval is not typically required, but there is no statement clarifying this
24. Availability of Data and Materials	No. There is no mention of the availability of data and materials

vaccinated individuals generally reported better HRQoL, likely due to the perceived protection against severe disease and reduced anxiety about COVID-19.

The use of the EQ-5D instrument across these studies consistently showed significant drops in HRQoL, particularly in the domains such as pain/discomfort and anxiety/depression. Halpin et al. found substantial declines in HRQoL among ICU and ward patients post-discharge, primarily due to persistent symptoms like fatigue and breathlessness [22]. Studies

by Weiwei Ping et al. in China and those conducted in Vietnam highlighted that pain/discomfort and anxiety/depression were the most affected domains, pointing to the physical and psychological toll of the pandemic [35, 43]. Navarro et al. and Mena Said et al. emphasized the impact of persistent symptoms such as olfactory dysfunction on HRQoL, showing how ongoing health issues post-COVID can significantly impair daily functioning and overall HRQoL [34, 37].

The COVID-19 pandemic has highlighted the importance of sociodemographic determinants in shaping HRQoL. Age, gender, education, employment status, marital status, and income significantly influence how individuals experience and cope with the pandemic. Addressing these determinants through targeted public health strategies and support systems is essential to mitigate the pandemic's adverse impact on HRQoL. Studies consistently indicate that older adults report lower HRQoL than younger individuals. This association is evident in the increased problems related to mobility and self-care among older populations and the exacerbation of chronic conditions that further diminish HRQoL [12, 17, 35, 42]. Gender disparities are also evident, with females reporting lower HRQoL and higher levels of anxiety and depression than males. The increased burden of multitasking, such as managing household responsibilities and supporting family members during the lockdown, is a significant stressor contributing to these differences. This trend was evident in multiple studies, including those by Ferreira et al., Nguyen et al., and Arab-Zozani et al., which attributed lower HRQoL in women to higher anxiety levels and the additional burden of domestic responsibilities and caregiving roles during lockdowns [12, 17, 42]. However, Van Rüth et al. did not find significant associations between HRQoL and gender within the homeless population, possibly due to the uniformity of environmental conditions faced by homeless men and women [42]. Marital status influences HRQoL, with single, divorced, or widowed individuals experiencing higher anxiety and lower HRQoL. These individuals often face increased feelings of loneliness and isolation during quarantine periods, exacerbating their mental health challenges. Widowed individuals, in particular, have been shown to have the lowest HRQoL scores among all marital status categories [13]. Ferreira et al. observed that married individuals generally reported better HRQoL than their single, divorced, or widowed counterparts, possibly due to the emotional and practical support provided by partners during lockdowns [17]. Similarly, Hay et al. observed that being married correlated with better HRQoL, while living alone negatively affected it [23]. These findings underscore the importance of social support systems in mitigating the adverse impacts of the pandemic on HRQoL. Higher levels of education were associated with better HRQoL. Educated individuals tend to have better access to information and resources, enabling them to cope more effectively with the challenges of the pandemic. Employment status also plays a critical role, with unemployed individuals reporting lower HRQoL. The stability and social interactions provided by employment significantly contribute to better mental and physical health [12, 17]. The job losses caused by the pandemic exacerbated stress and anxiety levels among the unemployed, as highlighted in the studies by Hay et al. [23]. Economic factors, including income level and financial stability, are crucial determinants of HRQoL. Higher income levels are consistently associated with better HRQoL, as financial resources enable access to healthcare, nutritious food, and a comfortable living environment. Conversely, financial strain during the pandemic has been linked to lower HRQoL. The study by Hay et al. and Ferreira et al. confirmed that increased income correlated with higher HRQoL scores during the pandemic [17, 23].

5.1 Strengths and limitations

The strengths of this systematic review include a comprehensive search strategy and the inclusion of diverse study populations, providing a broad understanding of socio-determinants of HRQoL during the COVID-19. The review considered both physical and psychological health, offering a holistic view of HRQoL. Additionally, the high response rate ensures that the findings are representative of the staff at the institution [16]. However, several limitations must be acknowledged. The heterogeneity among studies in terms of methodologies and populations can introduce biases and affect the generalizability of the findings. Additionally, the reliance on self-reported measures in many studies may lead to underreporting or overreporting of symptoms and HRQoL impacts. Cross-sectional design provides participants' HRQoL at a single point in time, limiting the ability to infer causality or track changes over time. The voluntary nature of the survey may have led to response bias, as those experiencing higher levels of burnout more likely to participate.

5.2 Recommendations for future research

Future research should focus on longitudinal studies to track changes in HRQoL over time, particularly in COVID-19 survivors. It is also important to explore the long-term impact of vaccination on HRQoL. Additionally, research should aim to understand the socio-demographic disparities in HRQoL outcomes, with a focus on developing targeted interventions for vulnerable populations. Studies should also consider using a combination of direct and indirect HRQoL measurement

tools to provide a more comprehensive assessment. Finally, integrating mental health support and rehabilitation programs in the research design will help in understanding their effectiveness in improving HRQoL post-COVID-19.

6 Conclusion

The findings from this review have significant implications for both clinical practice and policymaking. Health professionals should prioritize long-term follow-up of COVID-19 survivors to address persistent symptoms and provide targeted rehabilitation programs. Policymakers should consider socio-demographic disparities in the pandemic's impact when designing interventions, ensuring that vulnerable populations receive adequate support. Implementing mental health support systems and community-based programs can help mitigate the psychological burden and enhance resilience in affected individuals. In conclusion, this systematic review highlights the substantial and multifaceted impact of COVID-19 on HRQoL. The persistence of physical and psychological symptoms underscores the need for comprehensive long-term support for survivors. Addressing socio-demographic disparities and implementing robust mental health interventions will be essential for promoting resilience and improving the HRQoL in the post-pandemic era.

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