

Indirect impact of COVID-19 pandemic on health and wellbeing: a narrative review

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Abstract

Introduction. The COVID-19 pandemic had a profound impact on global health, notably affecting patients with non-COVID-19 conditions, who faced substantial disruptions in their treatment and care. The aim of this narrative review was to identify the main indicators used in literature to evaluate the indirect impact of COVID-19 on health and wellbeing.

Method. A literature search was conducted using PubMed from January 2021 to November 2022. The indicators were categorized into five main groups: burden of disease (BoD), life expectancy (LE), health-related quality of life (HRQoL), cost of illness and mental health status and were retrieved from 20 scientific articles.

Results. Disability-adjusted life years (DALYs) revealed substantial health losses; a decrease in LE was observed, with inequalities across population subgroups; HRQoL showed impairments in physical functioning, daily activities and emotional well-being; productivity losses were economically relevant and varied by context and elevated symptoms of anxiety and depression were reported.

Discussion. The compiled indicators may contribute to the development of sustainable pandemic mitigation policies.

Key words

- COVID-19
- life expectancy
- quality of life
- mental health
- illness cost

INTRODUCTION

The COVID-19 pandemic had a profound impact on global health, particularly for patients with non-COVID-19 conditions who experienced significant disruptions in their treatment and care. Hospitals postponed routine procedures for planned care [1-3], and public health systems issued guidelines to mitigate the risk of patients with cancer facing higher risks [4]. It was estimated that the disruption caused by the COVID-19 pandemic could result in an additional 18,000 cancer-related deaths in England (UK) [5]. A higher incidence of severe events in cancer patients have been reported based on a meta-analysis of 26 studies [6]. Furthermore, in June 2020, direct access to primary care was restricted, with general practitioners adopting telephone and

video consultations in place of in-person visits [7]. Visits to urgent and emergency care services also decreased significantly following the onset of the pandemic, which likely resulted in patients postponing or forgoing essential medical attention [8]. Some patients required emergency care as their conditions worsened due to the lack of timely treatment [9, 10], while hospitalizations for chronic conditions may have risen as a consequence of the social-distancing measures implemented [11].

The increased pressure on health systems, caused by worsened health-status of patients who forewent timely treatment during the pandemic, has two potential implications. First, it might increase the costs to the national health systems due to increased need of medication [12, 13] and longer working hours for

health-care staff [14] (<https://aspe.hhs.gov/reports/covid-19-health-care-workforce>). Second, it may neglect the health of some groups who are more vulnerable than others (e.g., those with underlying comorbidities, children, homeless, pregnant women, migrants and people with disabilities) [15]. Early evidence suggested large differences between groups. For instance, for cancer deaths and other indirect deaths (i.e., drug- and alcohol-related deaths, suicides, fatal accidents, and all other causes), excess years of life lost (YLL) indirectly attributable to the pandemic ranged from 11,710 (95% CI: 2,694-20,725) in the least deprived quintile to 18,298 (95% CI: 10,754-25,810) in the most deprived quintile in England and Wales [16]. The impact of COVID-19 restrictions has been uneven across communities, with areas of higher deprivation and those with ethnic minorities suffering the worst of COVID-19 (<https://ifs.org.uk/publications/are-some-ethnic-groups-more-vulnerable-covid-19-others>).

Different types of indicators have been used to assess the indirect impact of the COVID-19 health crisis, such as burden of non-COVID-19 diseases [17] or life expectancy (LE) non-attributable to COVID-19 disease, among other indicators. Some examples of reviews published between 2021 and 2022 have described the impact of COVID-19 pandemic on quality of life [18], burden of disease [19] and mental health in the general population and vulnerable groups [20].

This study aimed to conduct a narrative review to identify and describe the key indicators employed in the research literature to assess the indirect impact of COVID-19 on health and wellbeing.

MATERIALS AND METHODS

Design

We conducted a narrative review to provide an overview of the most relevant indicators across various topics. The studies relevant to this review had heterogeneous designs, and many lacked the use of established data collection protocols and theoretical frameworks necessary for a comprehensive and quantitative synthesis. Our narrative review – supported by a predefined search strategy and selection criteria – offered a more flexible and feasible approach for identifying and analysing the indirect impact of COVID-19 on health and wellbeing.

Eligibility criteria

A literature search was conducted on PubMed, covering the period from January 2021 to November 2022. The selection criteria included studies published in peer-reviewed journals in the English language. Country reports and policy briefs were excluded, as well as grey literature such as conference proceedings, dissertations, abstracts, unpublished studies, and books.

Search strategy

The indicators were categorized into five main groups: burden of disease (BoD), life expectancy (LE), health-related quality of life (HRQoL), cost of illness and mental health status. The groups of indicators were chosen through a consensus between the authors and other experts in the field, who argued these were highly

represented in the literature. The selection was based on previous guidelines [21-24].

Two reviewers applied the search strategy for each topic on November 30, 2022. Each search strategy included a combination of keywords with free text and Medical Subject Headings (MeSH) terms. Five collaborators from three European countries (Spain, Italy and Portugal) were allowed to modify search strategies to increase the chance of finding relevant articles (*Supplementary Material S1 available online*).

Data extraction

Each collaborator was asked to select two to three publications featuring the same health indicator measuring an important health area indirectly affected by the COVID-19 pandemic. For each selected publication, the authors were instructed to extract and report specific information, including: indicator's name, what the indicator measured, its relevance – particularly in the context of COVID-19 – how it was calculated, and general comments on its application, strengths and limitations. The characteristics and implementation of each indicator were discussed in relation to its use in similar studies identified through the same search strategy. Collaborators also wrote an introductory paragraph about the relevance of their assigned topic. All the completed responses were collected and reviewed for inclusion in a summary table (*Supplementary Material S2 available online*). This approach enables a focused synthesis of relevant evidence without the intention of quantifying the total number of retrieved publications. The included studies were selected collaboratively by the authors to ensure consistency and representativeness across the various indicators analysed.

RESULTS

The characteristics of the 20 studies included in the narrative review, and from which indicators were extracted, are reported in *Table 1*. The selection aimed at covering a range of geographic settings and study designs while maintaining a focus on clarity and relevance.

Burden of disease

The burden of disease (BoD) is an estimate of the impact of disease and injury on a population. It integrates the years of life lost due to living in poor health (non-fatal burden) with the years of life lost due to early death (fatal burden) [25]. The term “burden of disease” is commonly used to describe the total, cumulative impact of a specific disease or group of diseases on disability within a population. This encompasses not only the health effects but also the social consequences and the associated costs to society. The difference between optimal conditions, where everyone is free from disease and disability, and the cumulative current health status is described by the burden of disease. In the 1990s, the World Health Organization (WHO), together with Harvard University and the World Bank, developed a method for assessing the global burden of disease, based largely on statistical calculations of disability-adjusted life years (DALYs), which combine the time lost due to early mortality and the time spent living in poor health [26].

Table 1
Characteristics of the studies included in the narrative review

Author and year	Thematic area	Study design	Study country	Indicator/s extracted for this narrative review	Main results
Gravesteyn <i>et al.</i> (2021) [27]	BoD	Retrospective cohort study	The Netherlands	DALYs	The delay in surgical procedures led to a linear increase in DALYs per delay, with values ranging from 0.01 (shunt placement) to 0.23 (bypass surgery) DALYs/month.
Santomauro <i>et al.</i> (2021) [28]	BoD	Cross-sectional and longitudinal combination of studies	Worldwide	DALYs	Before the COVID-19 pandemic, major depressive disorder was responsible for 38.7 million DALYs globally, while anxiety disorders were responsible for 35.5 million DALYs. During the pandemic, major depressive disorder caused an additional 10.7 million DALYs, with 7.07 million among females and 3.62 million among males. Anxiety disorders caused an additional 9.05 million DALYs, with 6.11 million among females and 2.94 million among males.
Julien <i>et al.</i> (2022) [29]	BoD	Cross-sectional study	USA	DALYs	Drinking increases from 2020 to 2023 due to COVID-19 were projected to lead to 531,200 DALYs lost. This number was expected to rise significantly to 8,900,200 cumulative DALYs lost from 2020 through 2040.
Aburto <i>et al.</i> (2021) [30]	LE	Ecological study	England and Wales	LE at birth and lifespan inequality	The study found that LE at birth decreased during the first 47 weeks of 2020 in England and Wales. Women experienced a reduction of 0.9 years, while men saw a decrease of 1.2 years compared to 2019 levels.
Andrasfay and Goldman (2021) [31]	LE	Ecological study	USA	LE at birth and life expectancy at 65	This study presented estimated LE values under four projection scenarios. LE at birth would have been 78.61 y in 2020 had the COVID-19 pandemic not occurred, but all three mortality scenarios imply huge reductions in LE at birth for the USA in 2020. The medium scenario would bring about a decline of 1.13 y, whereas the higher and lower mortality scenarios project declines of 1.22 and 0.98 y, respectively. LE at age 65 y, which is estimated to have been 19.40 y in the absence of COVID-19, is projected to decline by 0.87 y under the medium scenario, 0.94 y under the higher mortality scenario, and 0.75 y under the lower mortality scenario. The disparities in LE declines were pronounced, with Black and Latino populations experiencing much larger reductions compared to Whites.
Ozyilmaz <i>et al.</i> (2022) [34]	LE	Ecological study	93 countries	LE at birth	Findings from social indicators show that LE negatively affects the number of deaths in the 25 th and 50 th quantiles. LE at birth and the share of the population over the age of 65 in the total population have a significant effect on the number of deaths. The population over the age of 65 has a statistically significant effect on the number of COVID-19 deaths in all quantile values.
Verveen <i>et al.</i> (2022) [48]	QoL	Prospective cohort study	The Netherlands	HRQoL-SF-36	Twelve months after illness onset, people with initial mild COVID-19 had health-related quality of life (HRQoL) within population norms, while those with moderate or severe/critical COVID-19 still had impaired HRQoL on more than half of the measured domains. Initial COVID-19 severity, migration background, number of comorbidities, and timing of public health measures all influenced long-term HRQoL outcomes.
O'Brien <i>et al.</i> (2022) [49]	QoL	Prospective longitudinal design	Ireland	HRQoL-SF-36	HRQoL measured by the SF-36 did not significantly improve in any domain over the 1-year follow-up. Scores remained lower than population norms in physical functioning, energy/vitality, role limitations due to physical problems, and general health. At 1 year, 31% of participants felt their general health was worse than a year prior.
Fernandes <i>et al.</i> (2021) [50]	QoL	Retrospective case-series study	Portugal	HRQoL-EQ-5D-5L	64.4% of COVID-19 critical illness survivors reported moderate to extreme problems in at least one dimension of the EQ-5D-5L questionnaire. The most affected areas were usual activities (51.1%), anxiety/depression (37.8%) and pain/discomfort (31.1%), followed by mobility (13.3%) and self-care (13.3%). The median self-rated health score (EQ-VAS) was 75.0 (on a scale from 0 to 100).

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Table 1
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Author and year	Thematic area	Study design	Study country	Indicator/s extracted for this narrative review	Main results
Kwon <i>et al.</i> (2022) [51]	QoL	Cross-sectional study	South Korea	HRQoL-EQ-5D	The study found that the overall EQ-5D index scores were significantly higher among individuals under quarantine during the COVID-19 pandemic (0.971) compared to those before the pandemic (0.964). Quarantine was associated with improved physical health dimensions, specifically showing significant improvements in "Pain/Discomfort" and "Mobility", but a significant deterioration in the "Depression/Anxiety" dimension.
Larsson <i>et al.</i> (2023) [52]	QoL	Prospective cohort study	Sweden	HRQoL-EQ-5D-5L and EQ-VAS	At both 4- and 12-month follow-ups, patients reported some problems in various dimensions, particularly in usual activity and pain/discomfort. There were no significant changes in any of the EQ-5D-5L dimensions between 4 and 12 months. Most of the participants reported lower EQ-VAS values than the general population at both follow-ups. For general health status, 28 (61%) participants at the first follow-up and 26 (57%) (p=0.414) at the second reported lower values than the general population.
Moens <i>et al.</i> (2022) [53]	QoL	Cross-sectional study	Belgium	HRQoL-EQ5D-3L and VAS score	89.58% of post-COVID-19 infected persons reported pain/discomfort, 82.45% indicated limitations when performing usual activities and only 13.16% indicated problems with self-care. The mean index score for normative population was significantly higher than the post-COVID-19 infected persons, with a mean difference of 0.31 (95% CI: 0.29 to 0.33, p<0.01). The mean score of chronic pain patients (PSPS-T2) was significantly lower than the score of COVID-19 infected persons, with a mean difference of -0.31 (95% CI: -0.29 to -0.33, p <0.01).
Barbieri <i>et al.</i> (2022) [54]	QoL	Cross-sectional study	Italy	HRQoL-KIDSCREEN-10	27% of parents' proxy reports indicated a low health-related quality of life (HRQoL) for their children. For children and adolescents aged 11-19 years: 33% self-reported a low HRQoL while 31% of parents reported a low HRQoL for their children in this age group. Children aged 7-10 years were significantly less affected by low HRQoL compared to children aged 11-19 years, according to proxy reports. Female adolescents showed significantly higher frequencies of low HRQoL than corresponding proxy reports. The self-reported low HRQoL of 33% in South Tyrol was similar to the 35% reported in Germany during the third wave of the COPSy Germany survey in September-October 2021 [55].
Ravens-Sieberer <i>et al.</i> (2022) [55]	QoL	Cross-sectional study	Germany	HRQoL-KIDSCREEN-10	The percentage of children and adolescents reporting low HRQoL increased substantially from 15.3% before the pandemic to 40.2% during the pandemic. Stratified by gender, a higher proportion of girls reported low HRQoL than their male peers before and during the pandemic. Younger children (aged 11-13) showed a greater decline in HRQoL compared to older adolescents (aged 14-17), rose from 7.7% to 41.3% in 11-to-13-year-old children and from 17.1% to 39.3% in 14- to 17-year-olds (p<0.001).
Van Ballegoijen <i>et al.</i> (2021) [57]	Cost of illness	Cross-sectional study	Belgium and The Netherlands	Productivity losses (iMTA Productivity Cost Questionnaire-IPCQ-)	5.1% of respondents in Belgium and 4.4% in the Netherlands reported losing their job due to the pandemic. About 39-40% of respondents in both countries were somewhat to extremely worried about losing their profession. Weekly work hours decreased from 34.4 to 26.9 in Belgium and from 30.6 to 26.6 in the Netherlands during COVID-19. 35.7% of Belgian respondents experienced absenteeism compared to 18.7% in the Netherlands. By contrary, 29.5% of Belgian respondents and 33.7% of Dutch respondents experienced presenteeism. The mean value of lost production per person per week, including absenteeism and presenteeism, was €161.39 for Belgium and €82.69 for the Netherlands.

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Author and year	Thematic area	Study design	Study country	Indicator/s extracted for this narrative review	Main results
de Paiva <i>et al.</i> (2022) [58]	Cost of illness	Cross-sectional study	Brazil	Rate of absenteeism per year and total cost of absenteeism per year	The mean sickness absenteeism rate was 3.25%. There was a significant increase during the pandemic period, with the rate rising to 5.10% compared to 2.97% in the pre-pandemic period. The total cost of sickness absence was R\$8,158,117.20, with a mean daily cost of R\$3,525.55. During the pandemic, the mean daily cost increased to R\$7,380.38, which is 2.49 times greater than the pre-pandemic period (R\$2,960.12).
Faramarzi <i>et al.</i> (2021) [59]	Cost of illness	Cross-sectional study	Iran	Lost productivity cost (\$US) due to absenteeism	The total cost of absenteeism due to COVID-19 among hospital personnel was estimated to be nearly \$1.3 million. The average cost per patient was \$671.4, with a median of \$649. The mean cost of absenteeism was higher among males (\$688.7) compared to females (\$659.9). Patients aged over 50 years had the highest mean cost (\$872.6), while those under 30 had the lowest (\$597.7). Physicians had the highest mean cost per patient (\$827.5), while other staff had the lowest (\$603.7). Permanent employees had a higher mean cost (\$756.2) compared to non-permanent employees (\$604). The total number of missed workdays was 32,209, with an average of 16.44 days per patient.
Davis <i>et al.</i> (2022) [60]	Mental health status	Cross-sectional study	Canada	GAD-7	82% of the home dialysis patients surveyed reported symptoms of anxiety and depression either "not at all" or "for several days" on the GAD-7 scale. The results indicate that most symptoms of anxiety were experienced "some days" or "never" in more than 80% of the respondents.
Buneviciene <i>et al.</i> (2021) [62]	Mental health status	Cross-sectional study	Lithuania	GAD-7	Both pre-existing medical conditions and poor perceived health status were associated with an increased risk of moderate to severe anxiety symptoms, as measured by the GAD-7 questionnaire. After adjusting for demographic and behavioural factors, pre-existing medical conditions were linked to a significantly higher risk for moderate to severe anxiety symptoms (GAD-7 score ≥ 10). When both pre-existing conditions and perceived health status were considered together, pre-existing conditions were associated with a 1.5-fold increased risk (OR 1.526, $p=0.016$), while poor perceived health status was associated with a 4.6-fold increased risk (OR 4.556, $p<0.001$) for moderate to severe anxiety symptoms.
Ho-Fung <i>et al.</i> (2022) [64]	Mental health status	Cross-sectional study	China (Hong Kong SAR and Shanghai), Norway, Sweden, Switzerland, Taiwan and USA	GAD-7	25.7% of pregnant women in the study had moderate to severe generalized anxiety symptoms, as measured by GAD-7 (score ≥ 10). The total median GAD-7 score was 6.0 (IQR: 3.0-10.0). Women with sick family members had higher GAD-7 scores (median 7.0 [4.0-12.00]) compared to those without (median 6.0 [3.0-9.0]), and this difference was statistically significant ($p=0.003$). Risk factors for higher GAD-7 scores (anxiety) included having a sick family member (aOR 2.218, 95% CI [1.376, 3.573], $p=0.001$) and experiencing a substantially stressful life event (aOR 2.427, 95% CI [1.471, 4.005], $p=0.001$). Younger age (18-30) was protective against anxiety.

BoD: burden of disease; DALYs: disability adjusted life-years; EQ-VAS: EuroQoL Visual Analogue Scale; EQ-5D-3L or 5L: EuroQoL 5-Dimension 3 or 5-level questionnaire; GAD-7: generalized anxiety disorder-7; HRQoL: health related quality of life; LE: life expectancy; QoL: quality of life; SF: short form.

A study of elective surgical procedures in a Dutch hospital estimated the health impact of postponing these procedures [27]. Survival data were used to inform the model, which incorporated years lived with disability (YLD) and years of life lost (YLL) due to premature death, resulting in the calculation of DALYs. DALYs were used to assess the outcome of delaying surgery. The expected health outcomes with surgery at two weeks were compared with the expected health outcomes at 52 weeks to determine the health lost per 50 weeks. This measure of health loss provided

an indication of urgency, which was later converted to health lost per month of delay. This was used to rank the surgical procedures, with a high DALYs/month indicating urgent surgery. The quality of data for this type of studies could be limited because the surgical procedures being evaluated are often part of standard clinical practice. Therefore, data may be biased (e.g., selection bias in the survival analysis of patients without treatment because patients opt for palliative care) or unavailable. The results from the indicator calculation provided valuable information for the development of a

decision model to support the prioritisation of surgical care in times of limited surgical capacity, such as the COVID-19 pandemic.

It was also observed that DALYs were used to quantify the impact of the COVID-19 pandemic on the prevalence and burden of major depressive disorder and anxiety disorders worldwide. The data revealed an increase in depressive and anxiety disorders in 2020 due to the pandemic [28]. Another study used DALYs to project alcohol-associated liver disease (ALD) from 2020 to 2040 in the USA and concluded that a short-term increase in alcohol consumption during the COVID-19 pandemic could substantially increase long-term ALD-related morbidity and mortality [29].

Life expectancy

The study of life expectancy (LE) in the context of the COVID-19 crisis allowed researchers to compare the cumulative effect of the pandemic with mortality rates from previous years and current trends across different countries. This comparison is feasible because LE is standardized and routinely monitored, allowing for the tracking of changes and differences in mortality [30]. This enables an analysis of the impact of the COVID-19 pandemic on survival rates while adjusting for the age distribution of the underlying populations [31]. LE at birth is defined as the average LE of a newborn baby, assuming no change in current mortality rates. Gains in LE at birth can be attributed to several factors, including improved standards of living, improved lifestyles and education, and better access to quality health services. This indicator is usually presented as a total and by sex, and is measured in years [32]. Another related measure is LE at 65: the average number of years a person of that age can be expected to live, assuming that age-specific mortality remains constant. Estimates of LE can vary by fractions of a year depending on the calculation used, which may vary slightly between countries [33].

In light of the COVID-19 pandemic, a cohort study analysed all-cause mortality for England and Wales calculating LE (average mortality) and the variation in length of life between individuals in a population (lifespan inequality) [30]. Estimating the number of deaths caused by the COVID-19 pandemic was crucial to understanding the impact of the disease. The authors assessed the impact of the COVID-19 pandemic on LE and lifespan inequality in 2020 by using baseline mortality data reflecting deaths in the absence of COVID-19 and applied fitted models to estimate excess deaths. LE at birth for women and men in 2020 was 82.6 and 78.7 years, respectively, with 0.9 and 1.2 YLL compared to 2019. Lifespan inequality decreased due to the rise in mortality among older age groups. Furthermore, LE was used to illustrate the impact of the Coronavirus pandemic on the Black and Latino populations in the United States [31]. Estimates were calculated for LE at birth and at age 65 for 2020, with results stratified by race and ethnicity. The study found that LE at birth in the US reached its lowest level since 2003, alongside a 0.87-year reduction in LE at age 65. The decline in LE at birth was 2.10 years for Black populations, 3.05 years for Latino populations, and 0.68 years for White

populations. Another study analysed confirmed cases and determinants of COVID-19 fatalities in 93 countries [34]. The study projected a mortality model that incorporated social indicators, including LE at birth, sourced from the World Bank Open Data (<https://data.worldbank.org/>).

LE at birth was strongly associated with the number of COVID-19 deaths in countries with a low number of cases (25th quantile). The study estimated that a 1% increase in LE corresponded to a 10.82% reduction in COVID-19 deaths. Conversely, a 1% increase in the population aged 65 and older was associated with an increase in the number of deaths. This effect is attributed to their inclusion in the group with a higher-risk for adverse outcomes related to COVID-19.

Health-related quality of life

COVID-19 can lead to varying outcomes, including persistent symptoms that impact the daily lives of those infected [35-38]. Furthermore, measures implemented to control the virus' spread caused disruptions to individuals' daily activities on multiple levels [18, 39]. Given this, assessing quality of life (QoL) and its association with the long-term health consequences of COVID-19 is essential [40, 41]. The long-term effects of COVID-19 infection or pandemic countermeasures can lead to physical and mental health deterioration, as well as impairments in health-related quality of life (HRQoL) [18, 39]. Various measurement tools have been used to evaluate HRQoL [42], many of which are widely validated across different languages. These instruments assess multiple dimensions of HRQoL, including physical, mental, social and emotional functioning [43]. Tools commonly used to evaluate the impact of COVID-19 infection or pandemic-related contexts on HRQoL include the Medical Outcomes Study Short Form 36-item health survey (SF-36) [44], the EQ-5D [45, 46] (<https://euroqol.org/euroqol/>) and the KIDSCREEN-10 index [47].

The SF-36 was used to assess how contextual factors, such as public health control measures, affected patients' recovery [48] and their ability to return to pre-infection levels of function [49]. Verveen *et al.* [48], in a cohort study conducted in the Netherlands, monitored individuals with a confirmed SARS-CoV-2 infection at 1 and 12 months post-diagnosis. The study aimed to assess the impact of infection severity on HRQoL in both the short and long term. One month after a COVID-19 diagnosis, HRQoL was significantly below the population average in all SF-36 domains among individuals with mild COVID-19, except for general health and body pain. However, after 12 months, the HRQoL levels were within population standards. The study by O'Brien *et al.* [49] assessed COVID-19 patients at 10 weeks, 6 months, and 1 year after hospital discharge to monitor which patients or groups experienced greater impairment in HRQoL. The authors found no change in SF-36 scores across any domain during the study period. The scores remained lower than population standards in the domains of physical functioning, energy/vitality, role limitations due to physical problems and general health.

The EQ-5D-5L was employed to evaluate the impact of a SARS-CoV-2 infection on HRQoL among patients aged 18 years or older in Portugal, between the 30th and 90th day after hospital discharge [50]. The authors found that 29 patients (64.4%) reported moderate to extreme problems in at least one dimension of the EQ-5D-5L questionnaire. The most affected dimension was usual activities (51.1%), followed by anxiety/depression (37.8%) and pain/discomfort (31.1%). Kwon *et al.* [51] used the instrument to evaluate the impact of quarantine on HRQoL among individuals aged 19 years and older in South Korea. A comparison was made between EQ-5D scores collected after the onset of the pandemic and data systematically collected before the pandemic, starting in 2008. The overall EQ-5D index scores were significantly higher in the group under quarantine during the COVID-19 pandemic (0.971 ± 0.064) compared to the pre-pandemic scores (0.964 ± 0.079 , Diff. 0.007 ± 0.101 , $p=0.043$). The EQ-5D was also employed to evaluate the burden of illness and its impact on health and work-related circumstances among patients who had been treated for SARS-CoV-2 infection in Sweden at both four- and 12-month intervals following their discharge from intensive care [52]. The findings revealed no improvements between the first EQ-5D score and the second follow-up in any of its domains: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Finally, a Belgian study evaluated the HRQoL of individuals who had recovered from COVID-19 and were active on social media platforms between June and August 2021. HRQoL was measured using the EQ-5D-3L tool. The authors found that low scores were associated with difficulties in performing activities and pain/discomfort across the EQ-5D-3L dimensions [53].

The KIDSCREEN-10, an instrument for assessing QoL in children, was used to evaluate the HRQoL of children in Italy during the second year of the pandemic. The objective was to identify strategies for safeguarding children's mental health. The study found that 33% of children and adolescents aged 11 to 19 years self-reported a low HRQoL, while parents reported a low HRQoL for 31% of their children in this age group [54]. Furthermore, the KIDSCREEN-10 was employed in a study utilising a representative sample of children and adolescents aged 7-17 years in Germany. The study measured the HRQoL of the participants before and after the onset of the pandemic. Up to 15.3% of children and adolescents reported low HRQoL prior to the pandemic ($n=146$; based on weighted data from the BELLA study), compared to 40.2% during the pandemic ($n=418$; based on weighted self-reported data from the COPSY study) [55]. The identification of children and adolescents' needs enables the dissemination of information regarding their mental health to policymakers, paediatric healthcare professionals and parents. This can be considered a strength of the tool, as it reports findings from both the children themselves and their parents' perspectives.

Assessing the population's HRQoL requires the use of valid instruments, such as the SF-36, EQ-5D, or KIDSCREEN-10 index, and the collection of primary

data. This process can be resource-intensive and expensive. Typically, these instruments must be administered after the exposure in question, such as a COVID-19 infection or the pandemic context, to capture relevant HRQoL outcomes. Consequently, the size of the studied sample or population may vary depending on the available resources and the specific research question. The resource-intensive nature of HRQoL assessments also leads to varying timeframes for data collection, which can impair the reliability of result comparisons between different populations. Consequently, the available data may not always be sufficient for disaggregating results to the extent necessary for comparing HRQoL across all population subgroups. This limitation can hinder the ability to draw comprehensive and equitable conclusions about the impact of events such as COVID-19 on different population subgroups. When data collection relies on self-administered methods, certain population subgroups may be less likely to provide or complete the questionnaires, thus limiting the ability to compare HRQoL across groups. Additionally, some HRQoL scales may not be suitable for all populations. For instance, the SF-36 is challenging to apply to individuals with severe mental disorders. Similarly, the KIDSCREEN-10 provides a single global HRQoL score, which can result in a loss of detailed information when compared to longer versions of the KIDSCREEN, such as KIDSCREEN-27 or KIDSCREEN-52 [56].

Cost of illness

The impact of the novel coronavirus on the ability to resume work and perform at a normal capacity after infection has been demonstrated [57, 58]. The term "productivity loss" can be defined in terms of two distinct categories: presenteeism, which refers to the inability to work at one's normal capacity, and absenteeism, which encompasses the inability to work at all [57].

A study conducted in Belgium and the Netherlands evaluated the impact of the pandemic on stress levels, QoL, medical resource utilisation and productivity losses in the general population during the initial eight weeks of the coronavirus lockdown. The indicator of productivity losses related to COVID-19, described in terms of absenteeism and presenteeism, was recorded using the Productivity Cost Questionnaire (iPCQ). The authors calculated the mean value of lost production among respondents in paid professions on a per-person and per-week basis. The number of hours lost due to the impact of the pandemic on remunerated work was calculated by multiplying the total number of hours lost by the average hourly income in a specific country, adjusted for age; all costs were presented as weekly costs in euros [57]. A similar study was conducted to estimate the lost productivity cost of absenteeism due to COVID-19 among hospital staff in Iran. The monetary value for a working day for absent employees was multiplied by the number of missed workdays to estimate the absenteeism cost expressed in US dollars [59]. Another study estimated the cost of absenteeism among healthcare workers in Brazil from 2014 to 2020. The cost of absenteeism was calculated similarly to previous studies; however, it excluded periods when workers

were receiving sickness benefit, as salaries were not paid during these times. The authors also calculated the rate of absenteeism per year by dividing the number of days absent in a year by the number of days that could have been worked. This was based on the weekly number of hours worked and the worker's job title, providing a clearer understanding of absenteeism relative to the total potential workdays in a given year [58].

Mental health status

The COVID-19 pandemic caused significant consequences on global mental health including fear of acquiring and spreading infection to family members, loneliness, anxiety, depression and suicide. These effects were likely driven by national lockdowns implemented to contain the virus spread, leading to isolation and family separation. Additionally, the proliferation of misinformation and disinformation on social media, low health literacy, scarcity of basic needs, financial losses and increasing fear and vulnerability due to the uncertainty of disease progression may also be contributing factors [60, 61]. Therefore, public health emergencies, i.e., the COVID-19 pandemic, can increase the risk of new-onset mental health complications or exacerbate pre-existing mental disorders in the general population and in vulnerable individuals with pre-existing conditions. Addressing the risks for mental health complications during health emergencies is crucial to ensure the optimal allocation of health resources and to mitigate the adverse consequences of the disease [62].

In a study conducted in Lithuania, it was observed that pre-existing medical conditions (e.g., cardiovascular, pulmonary, obesity, diabetes, mental disorders) were associated with an increased risk of mental health complications during the recent pandemic. The correlation between self-perceived health status and the likelihood of developing mental health issues during the pandemic was also highlighted [62]. The study specifically assessed depressive symptom severity and anxiety symptom severity, measured by the Generalized Anxiety Disorder-7 (GAD-7) score [63]. The GAD-7 score was also employed to assess the prevalence of perinatal anxiety, alongside depression and acute stress reaction, among pregnant women in Sweden. This was part of a cross-sectional study that also explored the association of these symptoms with mental health outcomes. According to the study, 121 participants (25.7%) exhibited moderate to severe generalized anxiety symptoms, as indicated by a GAD-7 score of 10 or higher [64]. In a single-centre study of home dialysis patients in Canada, the GAD-7 score indicator was employed to describe levels of anxiety and quality of life during the SARS-CoV-2 pandemic. In this case, 80% of respondents reported experiencing symptoms of anxiety and depression "some days" or "never" [60].

The use of validated generic scales, such as GAD-7, is an effective approach for the acquisition of indicators defining the impact of the COVID-19 pandemic on mental health. These scales are simple to use and provide standardized self-reported measures of core mental health disorder symptoms. However, they rely on self-reports and evaluate only probable diagnoses,

which should be confirmed by other means, such as psychiatric interviews. Moreover, they may not be appropriate for all population groups [63, 65, 66].

DISCUSSION

The impact of COVID-19 on global health conditions or health status has been assessed through various indicators, including DALYs, LE at birth or at 65 years old, HRQoL, cost of illness and mental health status. Some indicators, such as HRQoL and mental health outcomes, were evaluated using standardized scales obtained from different questionnaires [44, 46, 47, 63, 66].

According to the revised studies, DALYs revealed substantial health losses associated with delays in elective surgeries, increases in mental health disorders and alcohol-related liver disease. LE declined globally in 2020, with disproportionate reductions among Black and Latino populations in the United States. HRQoL scales (SF-36 and EQ-5D) showed impairments in physical functioning, daily activities and emotional well-being among COVID-19 patients, with children and adolescents also reporting significant deterioration, as shown by the KIDSCREEN-10. Productivity losses, quantified through absenteeism and presenteeism, were economically relevant and varied by context. Finally, mental health impacts were pervasive, with elevated symptoms of anxiety and depression reported in both the general population and high-risk groups, as identified using instruments such as the GAD-7. These indicators, widely used in scientific literature, have also been implemented in European policy documents and decision-making tools [23, 67-69].

Furthermore, these indicators not only were useful for assessing the effects of the COVID-19 pandemic, but they have also been widely applied to chronic and communicable diseases to capture indirect health impacts and guide public health decision-making. Overall, the indicators showed a widespread effect of the COVID-19 pandemic on health, economic and psychosocial dimensions across different populations and contexts.

Burden of disease

Burden of disease metrics, such as DALYs, facilitate monitoring the direct impact of COVID-19 infection on population health. They also offer opportunities to assess the indirect impact of the pandemic that has occurred due to national lockdowns and restrictions to vital healthcare services [70]. DALYs have also been used to assess the impact of other national public health programs and interventions around the world [71-73]. Their models translate distributed units of intervention into DALYs averted, allowing cost per DALY calculations and comparisons across programs and settings [74]. Such studies typically adopt cost-effectiveness calculations and cohort simulations to estimate the number of DALYs averted. This includes a wide range of health areas: mental health, infectious disease control, immunization or primary care coverage.

Life expectancy

The impact of the pandemic resulted in a reduction in life expectancy (LE) between 2020 and 2021 [75].

However, the precise age-specific mortality rates for any given birth cohort cannot be known in advance. As the impact of the pandemic in terms of mortality is decreasing, the actual life spans are likely to be higher than the LE estimates based on the average mortality rates in 2020. The studies included in this review highlight the diverse impacts of COVID-19 on LE and lifespan, emphasizing the inequalities that have emerged as a result of the pandemic [30, 31, 34]. To better inform national policies for future health crises, it is essential to stratify data by factors such as socioeconomic status, education level and ethnicity. Harmonizing these contextual variables is key to enhancing surveillance systems. Furthermore, in the studies reviewed, LE was calculated based on all-cause mortality, allowing the indicator to capture both the direct and indirect effects of COVID-19. Studies that identify specific causes of death could help distinguish between the direct and indirect impacts of a pandemic. However, during the first wave of a pandemic, when health systems are overwhelmed, such studies may not be feasible. In this context, the excess mortality indicator will continue to play a critical role in future health crises.

In addition, LE improvements are commonly used to assess the impact of national public health programmes and broader health policies around the world. This indicator is used in a way comparable to its application in assessing the effectiveness of lockdown measures during the COVID-19 pandemic. Numerous national public health programmes have demonstrated significant impacts on LE. A modelling study projected the effect of raising tobacco prices (by 5%, 10%, or 20%) on smoking behaviour, COPD burden, and LE in Italy (alongside England and Sweden). Using a multi-state simulation model and Italian demographic and smoking data, the study estimated that, under a 20% price increase, LE gains in Italy for a 20-year-old ranged from 0.25 to 0.45 years over 40 years, driven by reduced smoking and COPD incidence [76]. In the United States, a national analysis found that 44% of the 3.3-year increase in LE between 1990 and 2015 was due to public health improvements, including tobacco control and environmental health [77]. In England, the Health Inequalities Strategy (1997-2010) targeted deprived areas and successfully narrowed gaps in LE, reversing previous trends of widening disparities [78]. Modelling based on UK Biobank data suggests that middle-aged adults who adopt optimal dietary patterns could gain up to 10 additional years of life, depending on baseline habits [79]. Similarly, a European microsimulation study estimated that if all adults met physical activity guidelines, LE would increase by approximately 3 months, while also reducing chronic disease risk [80]. Lastly, global data from the Institute for Health Metrics and Evaluation (<https://www.healthdata.org/news-events/newsroom/news-releases/life-expectancy-increased-world-addressed-major-killers>) show that LE increased by 6.2 years worldwide between 1990 and 2021 [81], largely due to public health interventions that reduced infectious and chronic disease mortality.

Health-related quality of life

Several well-designed studies have demonstrated improvements in health-related quality of life (HRQoL) associated with public health interventions. For example, a US-based community lifestyle program adapted from the Diabetes Prevention Program (Group Lifestyle Balance Program) significantly improved EQ-5D-VAS scores (+7.4 at 6 months, +6.7 at 12 months) and modestly increased EQ-5D index values among adults with prediabetes or metabolic syndrome, demonstrating the utility of EQ-5D in evaluating community-based diabetes prevention efforts [82]. In China, a community-based public health service targeting middle-aged and older adults with chronic conditions constructed an SF-36-based HRQoL scale from CHARLS variables and found that this service demonstrated a significant association with an increased overall SF-36 score ($\beta=3.539$, $p<0.001$) supporting the use of SF-36 to assess programmatic interventions in chronic disease management [83]. A Brazilian study comparing elderly participants in a community physical activity program with sedentary peers and found higher scores in SF-36 domains of functioning capacity and general health perceptions for program participants [84]. Although fewer studies directly link KIDSCREEN-10 to specific public health programs [85], its use in population-based surveys supports its potential to evaluate child and adolescent health initiatives. Together, these studies illustrate the value of EQ-5D and SF-36 in measuring QoL gains from public health interventions at sub-national levels [86-88].

Cost of illness

Studies have used cost-of-illness measures – including sickness absence days, production loss, and presenteeism – to evaluate workplace or community-level public health interventions. For example, a cluster-randomised controlled trial in Sweden implemented a work-directed problem-solving intervention within occupational health services for employees with common mental disorders. It led to almost 15 fewer registered sickness absence days over one year compared to usual care – a reduction that was cost-beneficial from a societal perspective, despite increased short-term productivity loss recorded by employers [89, 90]. A follow-up within primary care showed similar reductions in self-reported sick leave and improved mental health and return-to-work, again demonstrating effectiveness using real-world registry data [91]. Additionally, a systematic review of workplace nutrition and physical activity programs demonstrated that multi-component interventions (including organizational, environmental, and individual-level elements) consistently reduced absenteeism and improved work performance and productivity [92].

In terms of the indirect impact of communicable diseases measured with cost of illness indicators there are studies about influenza vaccination [93, 94]. The systematic review of workplace influenza interventions across multiple countries concluded that both pharmacological and non-pharmaceutical strategies, including paid sick leave, significantly reduced absenteeism and

were consistently cost-saving from the employer perspective [94].

Mental health status

Mental health screening tools such as the GAD-7 and GHQ-12 (General Health Questionnaire) have been widely used in cross-sectional and cohort studies to document the psychological impact of communicable disease outbreaks [95, 96]. However, despite their frequent use in epidemiological monitoring, these mental health instruments are rarely embedded in formal evaluations of non-pharmaceutical public health interventions – such as mass testing, lockdown mandates, or vaccination rollouts. For example, a small mobile telephone survey measured anxiety using GAD-7 during the early phase of COVID-19 in Wuhan and Shanghai in China but did not tie changes in mental health to any specific intervention [97]. More broadly, most public health policy evaluations focus on clinical and epidemiological outcomes – such as infection rates, hospitalizations, and mortality – while mental health metrics are often included only in secondary analyses or smaller sub-studies. This trend was evident in longitudinal UK studies that used the GHQ-12 to track mental health changes before and after national lockdowns, though without linking those changes directly to specific policies or intervention efficacy [98].

Strengths and limitations

We have emphasized the identification of methodological issues and the characteristics of the indicators used across the literature, rather than the findings of individual studies. While these indicators provided valuable insights, limitations included resource-intensive data collection, reliance on self-reports and potential sampling biases. Furthermore, the main limitation of rating scales is the subjectivity in the allocation of scores and the ordered level of items (representing a sorted classification rather than true numerical values) adopted for the majority of them. Nevertheless, rating scales are easy to apply in a multitude of contexts and settings, necessitating no supplementary resources or expenditures. They encompass numerous aspects of health status, providing a comprehensive overview of physical, mental and social wellbeing. These characteristics have facilitated their use as indicators during the pandemic, enabling comparison with previous years in research studies.

CONCLUSIONS

The present review offers a rapid vision on the indirect impact provoked by the COVID-19 crisis, presenting a comprehensive synthesis of health indicators identified through extensive research, evaluating the indirect effects on health status and wellbeing for both COVID-19 and non-COVID-19 patients.

Although the pandemic has ended, understanding the key indicators used to evaluate health status and wellbeing remains essential. Lessons learned during the pandemic have underscored the critical importance of preparing robust, inclusive and resilient health systems capable of adapting to challenges and changes across various levels. Such systems should ensure the continu-

ity of medical consultations in both primary and specialized care, which were affected not only by the excessive burden on healthcare workers but also by the impact on patients in long-term care facilities with main focus on mental health services of long term care recipients and workers [99].

The indicators identified in this review could serve as valuable tools for assessing the impact of future pandemics. To maximize their utility, it is essential to standardize their calculation, facilitating comparisons over time and across different populations, settings and countries. During global health emergencies, having a harmonized, equity-sensitive set of indicators, clearly disseminated through policy documents and decision-making tools and categorized by the primary areas affected, is crucial. Such a framework would enable public health institutions to monitor disease elimination strategies, implement early prevention measures and sustain robust health systems, all with the overarching goal of preserving the physical and mental health of populations.

Despite the extensive body of evidence reviewed, significant gaps persist – especially concerning the pandemic's impact on specific occupational groups such as healthcare workers, educators, and frontline service providers. Urgent research is needed to evaluate the long-term physical and mental health effects on these populations and to guide the development of occupational health policies that prioritize their safety and psychological well-being. These indicators should be systematically integrated into both research frameworks and policy planning to ensure better preparedness and equitable responses in future public health emergencies.

This review summarizes the evidence on the indirect impact of COVID-19 on health and wellbeing, aiming to guide the development of priorities and mitigation strategies to support recovery. The compiled indicators can contribute to shaping sustainable pandemic response policies.

Disclaimer

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Authors' contributions

TVG drafted the manuscript. TVG and CG developed the search strategy. CG, TVG, CRB, AD and MJF contributed to the development of the selection criteria and data extraction criteria. CG, TVG, BU, RFS and LP retrieved papers, indicators and their characteristics. All Authors read, provided feedback and approved the final manuscript.

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Data availability

The data underlying this article are available in the article and in its *Supplementary material available online*.

Conflict of interest statement

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