Deliverable 5.2

Roadmap of indicators, methodologies, data pathways and needs across Europe for research on health outcomes, gap analysis and monitoring COVID-19 impacts assessment

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Executive summary – Chapter 1 – subtask 5.1.1 and 5.1.4

In response to the unprecedented global crisis created by the COVID-19 pandemic, a vast amount of research has been published since the beginning of the outbreak in later 2019. This extensive body of literature has provided valuable insights to understand better the direct and indirect effects of this unknown disease. However, the various methodologies and data pathways employed across these studies have led to a heterogeneous evidence base, eventually posing challenges for interpreting, synthesising, and comparing findings. As a result, there is a pressing need for a comprehensive overview and analysis of the research landscape and to identify commonalities, gaps, and potential areas for improvement, not only in COVID-19 impact research but also for better preparing the response to a future health crisis.

In this report, we thoroughly examine the methodologies and data pathways used in studies investigating the direct and indirect impacts of COVID-19. A systematic approach was used to ensure the inclusion of high-quality research while also accounting for the diversity of perspectives and the global nature of the pandemic. The study selection criteria are carefully explained, providing a transparent methodology overview. The report painstakingly details the study selection process, which includes a thorough review of various study designs, statistical methods, and data pathways. A text-mining approach based on the search for specific keywords and terms related to study designs, statistical methods, and data sources was then employed to provide a representative snapshot of the research landscape.

Our findings present the study designs, statistical methods, and data pathways mentioned more often in the methods section of articles reporting research on the COVID-19 impact. Among the 4463 articles analysed, surveys (22.4%, n=998) and cohort (22.0%, n=984) designs were more often identified, meaning the preference for these designs in conducting COVID-19 impact research. Regarding the statistical methods, descriptive statistics were mentioned in most articles analysed (88.0%, n=3937). Moreover, elementary statistical tests identified more often were student's t-test (25.5%, n=1138), chi-square (22.0%, n=984), Fisher's exact (13.6%, n=606) and Mann-Whitney (11.6%, n=519), whereas logistic (23.3%, n=1038) and linear (7.7%, n=342) regression were regression techniques more frequently used. Data sources were mainly comprised of primarily collected data identified through mentions of surveys or questionnaires (31.5%, n=1408). However, the use of hospital admission data was also mentioned in a significant number of articles (15.7%, n=701).

The report provides a thorough review of the research on COVID-19's effects, emphasising the significance of a methodical and thorough examination of the available research to identify findings supported by evidence and serve as a basis for policy recommendations.

Key points – Chapter 1 – subtask 5.1.1 and 5.1.4

- In order to successfully address the issues brought about by the COVID-19 pandemic, policymakers and stakeholders should base their choices on the synthesized findings from the substantial body of research.
- To guarantee the quality and dependability of findings, future research should continue to follow strict and open procedures. This will promote the creation of evidence-based policies and more efficient decision-making.
- Policymakers should emphasize evidence-based interventions to mitigate the pandemic's negative impacts. To create resilience and decrease future vulnerabilities, key focus areas should include economic recovery, social support programs, and strengthening healthcare infrastructure.

Executive summary – Chapter 2 – subtask 5.1.2

During the first epidemic wave, surveillance focused on quantifying the magnitude and the escalation of a growing global health crisis. Basic indicators, such as the number of cases or rates of new cases and deaths, were used to assess risk. Later, the scientific community took action by evaluating figures and identifying vulnerable population groups, using indicators measuring the direct impact caused by the COVID-19. We aimed at synthesizing the contribution of the scientific community to assess the direct impact of the COVID-19 pandemic on population health through indicators reported in research papers.

We conducted a rapid scoping review to identify and describe health indicators used to evaluate the direct impact of COVID-19. Articles published between January 2020 and June 2021 were retrieved from PubMed, EMBASE and the WHO COVID-19 database. Titles and abstracts were screened first by 15 experts from European public health institutions.

From 3891 records reviewed, a final sample of 35 articles was selected. Direct impact indicators of COVID-19 identified included morbidity indicators, classified as indicators of prevalence, incidence, transmissibility and underreported infection. Mortality was registered as mortality rates, case fatality rates and time to death. A third group of indicators was reported in a severity category: complications, mechanical ventilation, hospitalization, people requiring ICU admission, time from hospitalization to ICU admission. We also conducted an online survey to find out how the indicators retrieved from the scoping review research matched with those used in policy monitoring or decision tools deployed in Europe to tackle the COVID-19 crises. The policy documents and decision tools reported in the survey mainly assessed COVID-19 impact using morbidity indicators followed by mortality indicators.

The indicators collated here might be useful to assess the impact of future pandemics. Therefore, it is crucial to harmonise their calculation to allow for comparisons between settings, countries and different populations. For example, most studies identified in the scoping review estimated “cumulative incidence” for study periods ranging from 3 to 10 months when reporting new cases in the population, instead of 14-day periods used in the COVID-19 dashboards of the ECDC and WHO, respectively.

Key points – Chapter 2 – subtask 5.1.2

The key observations from the rapid scoping review and the survey on policy monitoring documents and decision tools about indicators of direct impact of COVID-19 are:

- Indicators of direct impact of COVID-19 included in the scientific literature match with those found in policy monitoring documents and decision tools and the ones used by surveillance systems or enlisted by international health organisations to allow cross-national comparisons.

- The multiple possibilities to calculate most of the indicators allows to apply them to specific study needs and local particularities. However, a process of harmonisation is required to make rapid comparisons in future pandemics or health crises.
- Data sources are similar, potentially allowing to incorporate new or enhanced indicators to common indicators lists such as *The European Core Health Indicators* (ECHI) shorlist.
- The lack of policy monitoring documents at national level and their disparity across European countries to tackle the COVID-19 pandemic should be overcome with guidelines to elaborate similar documents of contingency against future health crises.

Executive summary – Chapter 3 – subtask 5.1.3

Patients suffering from non-COVID-19 conditions faced disruption in their care and treatment. Our aim was to describe in a narrative review the main indicators used in the research literature that evaluates the indirect impact on health, wellbeing and medical care disruptions caused by the COVID-19 disease.

A literature search was conducted via PubMed with date parameters of January 2021 to November 2022. The selection criteria included studies published at peer-reviewed journals written in English. Country reports and policy briefs were not included. Grey literature such as conference proceedings, dissertations, abstracts, unpublished studies, and books were also excluded. The search strategy was carried out on November 30th 2022 and twelve collaborators conducted the indicator data extraction. In addition, indicators used in policy monitoring documents or decision tools were searched via a survey completed by PHIRI partners. Among the 42 included studies, 17 correspond to health and wellbeing such as burden of disease, quality of life, cost of illness or mental health. Other studies included indicators of indirect of COVID-19 related to medical care disruptions for non-COVID-19 patients, i.e.: availability of specialised health care, delayed/cancelled programmed surgeries, primary care visits delay, reductions in visits and hospitalizations of non-COVID-19 patients with chronic condition, perinatal screening, cancer screening and screening of non-COVID-19 infectious diseases. A total of 15 questionnaires were completed, from experts of Belgium, Croatia, Estonia, Germany, Latvia, the Netherlands and Romania, providing examples of how the indirect impact indicators were used in policy documents.

The present review offers a rapid vision on the indicators used to measure the indirect impact provoked by the COVID-19 crisis on health status and health systems management. The knowledge of main indicators involved in the evaluation of health status and medical care will allow us to provide quality and safe care for our patients with minimal interruption of services and to prepare the healthcare systems to future health crisis. Therefore, it is important to have a harmonised set of indicators on hand, disseminated in policy documents and decision tools as well as classified by main affected areas.

Key points – Chapter 3 – subtask 5.1.3

The key observations from this narrative review on the indicators of indirect impact of COVID-19 are:

- The long-term impact of COVID-19 infection could impair the health-related quality of life.
- COVID-19 can impact the ability to return to work and perform at normal capacity after the coronavirus infection and it is evaluated by "productivity losses" in terms of absenteeism and presenteeism in healthcare workers.
- The COVID-19 pandemic has caused negative consequences on global mental health, in particular in anxiety disorders.
- The COVID-19 pandemic disrupted the normal functioning of health services and their utilisation to among others worldwide primary care, specialised services, emergency department visits, screening programmes, hospitalisations and scheduled surgeries.
- Disruptions to systems and processes of care affected population's health specifically due to delays in diagnosis, cancelled visits and treatments and care management of chronic conditions (e.g. cancer, diabetes, patients treated for HCV infection). Diagnostic and treatment delays occurred because of the substantial disruptions across all major health areas, such as communicable and non-communicable diseases, maternal and newborn health.

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PHIRI: Roadmap of indicators, methodologies, data pathways and needs across Europe for research on health outcomes, gap analysis, and monitoring COVID-19 impacts assessment

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I. Introduction

The impact of COVID-19 extended beyond those of a communicable disease. COVID-19 has affected health services having a direct effect as an infectious disease. COVID-19 has also triggered the overall mortality and burden of disease through its impact on non-communicable diseases (1). This repercussion has also been quantified in terms of the economic burden on healthcare resource utilisation (2).

Between January 2020 and December 2021, the total death toll directly or indirectly (“excess mortality”) associated with the COVID-19 pandemic was estimated at 14.9 million (13.3 million to 16.6) (3). The report from the European Centre for Disease Prevention and Control (ECDC, July 2022) informed that there were 535,143,050 COVID-19 cases and 6,328,694 deaths (4). At the moment of updating this report, pooled rates of case notification (all-age and among those aged 65 years and above), hospital, ICU admissions, and COVID-19-related deaths have declined, currently remaining at the lowest levels observed in the past 12 months (5).

Timely implemented containment measures have shown wide variation in COVID-19 cases and associated deaths among countries. Up to 25 April 2020, Hong Kong had among the lowest incidence and mortality (135.5 and 0.5 per 1,000,000 population) in the world (6,7). However, the late adoption of measures, such as the strict non-pharmacological limitations (movement restriction, physical distancing, and isolation for citizens) implemented in Spain, did not prevent it from being one of the countries most affected by the COVID-19 pandemic. During the first epidemic wave, surveillance focused on quantifying the magnitude and the escalation of a growing global health crisis. Basic indicators, such as the number of cases or rates of new cases and deaths, were used to assess risk. Then, the scientific community took action by evaluating figures and identifying vulnerable population groups, using indicators measuring the direct impact caused by the COVID-19 disease. Soon, researchers and clinicians from other areas like cancer or mental health realised that COVID-19, together with non-pharmacological measures, could also be affecting the population’s health and causing an even wider health crisis. Therefore, a vast amount of scientific literature was produced using different types of indicators to describe the indirect impact of the COVID-19 pandemic on the population’s health.

The present report outlines the work conducted within the framework of task 5.1 “COVID-19 impact indicators and methodologies”, as part of the PHIRI project aimed at developing new population health information research infrastructures to combat future health crises.

Chapter 1 refers to the work accomplished mapping different research methodologies used in research aiming to measure COVID-19’s direct and indirect impacts (subtask 5.1.1) and synthesising research and data pathways for analysing the impact of COVID-19 (subtask 5.1.4)

Chapter 2 refers to the work accomplished identifying methodological issues and direct impact indicators (subtask 5.1.2), providing a set of indicators to evaluate the direct impact of COVID-19 on healthcare based on research studies.

Chapter 3 refers to the work accomplished identifying indicators of COVID-19's indirect impact (subtask 5.1.3)

II. Conclusion

For this task, a solid foundation has been developed to evaluate the direct and indirect impacts of COVID-19 on population wellbeing, morbidity and mortality. This task has looked at how the different experts faced the COVID-19 crisis harmonising the global threats, novelties and innovative ways deployed in the areas of health information, research methodologies and assessment of health impacts. The studies carried out for this task showed that the amount of evidence published and the surveys conducted reflect how the scientific community rapidly readjusted data collection during physical distance rules, despite the limitations associated with remotely collected data. Describing the evolution of the use of study designs and statistical methods in COVID-19 research can contribute to understand which research gaps need to be addressed, identify needs in harmonising research methods, and inform on building capacity to better prepare for other health crises. In addition, this task has allowed to identify the overall indicator background used in scientific publications, policy monitoring documents and decision tools during the first waves of the pandemic. The indicators collated for these comprehensive reviews of papers, documents and tools might be useful to estimate the impact of future pandemics. Therefore, it is crucial to harmonise their calculation to allow for comparisons between settings, countries and different populations. Agreed indicators might support the response of future pandemics accelerating investigations using aggregated and cross-national information which might be considered for decision makers. Scientific journals and funding bodies could support the selection of indicators from an internationally agreed shortlist when a health crisis like COVID-19 begins. This way, researchers would be able to compare the vast number of technical documents and scientific publications quantitatively and cross-nationally.

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I. Chapter 1 – Mapping review of methodologies and data pathways of COVID-19 impact research

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A. Executive summary

Introduction and Background

The report provides a thorough review of the research on COVID-19's effects, concentrating on its effects on the economy, society, and health. It is essential to comprehend the pandemic's complex effects in order to develop effective mitigation and recovery plans given the unprecedented worldwide disruption it has caused. The study emphasizes the significance of a methodical and thorough examination of the available research to identify findings supported by evidence and serve as a basis for policy recommendations.

Methodology and Study Selection

A systematic approach was used to ensure the inclusion of high-quality research, while also accounting for the diversity of perspectives and the global nature of the pandemic. The study selection criteria are carefully explained, providing a transparent overview of the methodology. The report painstakingly details the study selection process, which includes a thorough review of various study designs, statistical methods, and data pathways.

Findings and Conclusions

The report summarizes the economic, social, and health effects of COVID-19 and illustrates them with tables and figures. The findings emphasize the pandemic's far-reaching effects, which include significant disruptions in economic growth, exacerbation of social inequalities, and a strain on global healthcare systems. The report is an invaluable resource for comprehending the scope and complexities of the pandemic's impacts.

Recommendations

This work intended to describe which study designs and statistical methods were used to assess direct and indirect impacts of COVID-19. The information obtained and conclusions derived sustained the structuring of some recommendations to consider for further research:

- Given the substantial body of research, policymakers and stakeholders should base their choices on the synthesized findings to address the issues brought about by the COVID-19 pandemic successfully.
- Policymakers should emphasize evidence-based interventions to mitigate the pandemic's negative impacts. In order to create resilience and decrease future vulnerabilities, key focus areas should include economic recovery, social support programs, and strengthening healthcare infrastructure.
- Future research should continue following strict and open procedures to guarantee the quality and dependability of findings. This approach will promote the creation of evidence-based policies and more efficient decision-making.

B. Background

1. Mapping review on methodologies and data pathways of COVID-19 impact research

The unprecedented COVID-19 pandemic has had a profound impact on public health, economies, and societies worldwide. In response to this global crisis, the scientific community has rapidly produced a vast amount of research to better understand the direct and indirect effects of an unknown disease which progressed quickly since the first outbreak surged in the later 2019. This extensive body of literature has provided valuable insights into the transmission dynamics, clinical manifestations, and societal consequences of the pandemic that this new virus originated. However, the variety of methodologies and data pathways employed across these studies has led to a heterogeneous evidence base, which can pose challenges for interpreting, synthesising, and comparing findings. As a result, there is a pressing need for a comprehensive overview and analysis of the research landscape to identify commonalities, gaps, and potential areas for improvement in COVID-19 impact research.

In this report, we present a thorough examination of the methodologies and data pathways used in studies investigating the direct and indirect impacts of COVID-19. By employing a text-mining approach based on the search for specific keywords and terms related to study designs, statistical methods, and data sources, we aim to provide a representative snapshot of the research landscape. Our findings will not only offer a better understanding of the current state of COVID-19 impact research but also serve as a foundation for the development of a roadmap to harmonise research practices, facilitate cross-country comparisons, and ultimately, guide evidence-based policymaking in response to the pandemic and future public health emergencies.

The report is structured as follows: first, we present the methods employed in our literature search and analysis, including the databases used, search strategies, and data extraction processes. Next, we discuss the main findings, highlighting trends in study designs, statistical methods, and data sources utilised in the COVID-19 impact research. We then delve into a detailed analysis of the identified patterns, exploring their implications for the interpretation and synthesis of findings, as well as potential opportunities for improvement. Finally, we conclude by outlining the limitations of our study and providing recommendations for future research in this area.

C. Approach for data collection

This literature review was conducted under the subtasks T5.1.1 and T5.1.4 and looked at the evidence documenting the impact of COVID-19 on the population, mapping methodologies, and data pathways used. The COVID-19 crisis impacted the human population directly and indirectly (please, see **¡Error! No se encuentra el origen de la referencia.** – PHIRI conceptual framework of COVID-19 impacts). Thus, this literature review considered research evaluating the COVID-19 impact on a wide range of issues, such as on well-being and health, its socioeconomic impact, or even how it affected non-COVID health care.

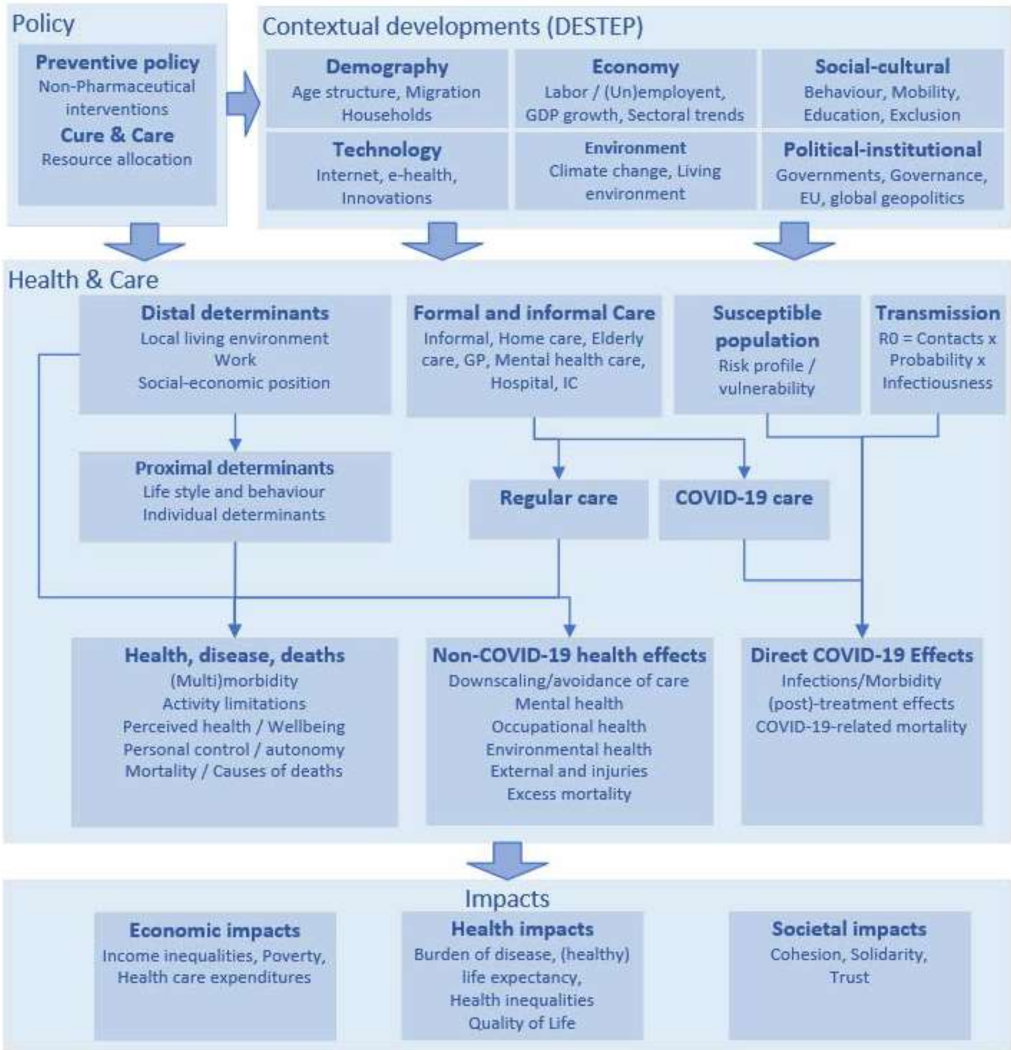

Figure 1. PHIRI conceptual framework of impacts of COVID-19

1. Literature search strategy

Due to the specificity of this research's purpose, the PubMed database was used to gather scientific literature records evaluating any COVID-19 impact, using data and describing the research methods undertaken. Therefore, as the primary pillar of this search strategy, several variations of the term "covid-19" were employed to meet several forms and terms used to refer to the disease since the pandemic's beginning. The search strategy for the term "covid-19" used for this review was created within task 5.2 to conduct a systematic review for studying the aetiological and prognostic roles of frailty, multimorbidity, and socioeconomic characteristics in the development of SARS-CoV-2 health outcomes. The protocol for this systematic review was already published (1), and the results are available in the PHIRI deliverable 5.1. The search strategy used for the term "covid-19" is detailed in Appendix 1. Secondly, the term "data" was also used to minimise the probability that the PubMed search would retrieve studies that had not used data and, consequently, had not referred to that. Using "covid-19" and "data" terms was based on the rationale that this search strategy could retrieve COVID-19-related research reporting information regarding data generation and collection up to the analysis of COVID-19 impacts. Finally, a date of publication filter was applied to records retrieved with “covid-19” and “data” search strategy parameters to include only articles published between the beginning of the COVID-19 crisis and November 2020, when the PHIRI project started.

2. Titles and abstracts screening

The records retrieved by the literature search strategy were then extracted from PubMed and uploaded to the Rayyan tool for systematic reviews. Even though a systematic review approach was not followed to conduct this review, the Rayyan tool was used to manage the screening process. After the removal of duplicated records, the titles and the abstracts of the references were screened to include only original research evidence aiming to measure the direct or indirect impacts of COVID-19. One researcher individually screened all PubMed records and judged if the studies reported matched the purpose of this review and did not fulfil any exclusion criterium. Therefore, the exclusion

Box 1. T5.1.1 review - exclusion criteria of for titles and abstracts screening

1. Records without abstract information
2. Language other than English (title or abstract)
3. Not related to the evaluation of COVID-19 impact
4. Not an original research or with no primary empirical data
    a) Reviews (narrative, systematic, scoping, ect.)
    b) Editorials, opinions, guidelines, consensus statements
    c) Study protocols
    d) Letters, comments, responses or replies which do not report substantive new data or analysis
    e) Corrections, errata, retractions
    f) Patents
5. Efficacy/validation studies (protective equipment, diagnostic tests, other medical procedures)
6. Studies with animals (not humans), *in vitro* or *in silico* studies, other laboratory studies
7. Duplicated records

criteria detailed in the Box 1 were adopted to guide the selection of references whose information fitted this literature review’s purpose.

A second screening was performed with the records included in the first screening. This second screening aimed to adjust and validate the options of the previous one because a less strict criterium was followed in the first when choosing which records evaluated the COVID-19 impact, mostly the indirect. The rationale for following less strict criterium during the first screening was to be inclusive regarding the several forms of how COVID-19 impacted the human population, according to Figure 1. Consequently, this second screening excluded some articles included in the first screening, using the same exclusion criteria but adapting what was considered to evaluate the direct or indirect impacts of COVID-19.

Therefore, records without abstract or presenting the information, i.e., title and abstract, in a language other than English were excluded. These two criteria were considered because titles and abstracts were also analysed, and the results could be impaired if the text in different languages was compared. Then, articles not reporting evidence of any COVID-19 direct or indirect impacts or any factor which could affect those impacts were excluded. Additionally, articles reviewing literature or without original research were excluded as well, such as editorials, opinions, protocols, or corrections. Furthermore, reports on validating protective equipment, medical procedures, or research tools for data collection were excluded, as were those reporting on laboratory studies, such as in vitro, in vivo, in silico, or with animal models. Finally, duplicated records were excluded, if any, as were those reporting a pre-print study from another one published in a peer-review journal further.

In addition, studies marked as included during the screening stage were coded as evaluating an indirect impact of COVID-19 to allow the disaggregation of results on methodologies and data pathways by type of impact. The criterium used to classify the COVID-19 impact as direct or indirect regarded whether outcomes were directly related to the disease, such as SARS-CoV-2 infection and COVID-19-related hospital admission and deaths, or if outcomes were related to other determinants of health affected by COVID-19 or the pandemic context, such as mental health, air quality or employment.

3. Fetching full and methods section texts

After the screening of titles and abstracts was finished, the full text of each article included in the final sample was extracted. As all articles' records were retrieved from the PubMed database, the R software was used to fetch each article's full text and methods section from PubMed Central® (PMC). PMC is a free full-text archive of articles from journals on biomedical and life sciences and includes (https://www.ncbi.nlm.nih.gov/pmc/). The articles' full text is available in PMC in the XML format and can be fetched using the "rentrez" R package (https://CRAN.R-project.org/package=rentrez). However, some articles are not published as open-access and could not be available in PMC. If not, the full text of those articles was not fetched. Moreover, the title of the section where methods are described can differ depending on the template or instructions each journal provides or the way authors report it. Additionally, the articles' structure can differ, and the methods section can be presented after the discussion section rather than after the introduction, as usual. These facts impaired how the methods section text was fetched, and gathering it for all articles with an available full text was impossible. Where methods could not be fetched, the full text was used to describe the methodologies and data sources rather than only the respective methods section.

4. Text analysis to describe methodologies and data pathways

The methodologies and data pathways used in COVID-19 impact research were described following a text-mining approach, focusing on the information provided by the title, abstract, publication date, full text, and the methods section of each article. The R Studio (version 2023.03.0), with the R statistical language version 4.2.2 (2), and text-mining-related packages were used to conduct the analyses, such as the "tm" (https://cran.r-project.org/package=tm), "stringr" (https://cran.r-project.org/package=stringr), "dplyr" (https://cran.r-project.org/package=dplyr), "NLP" (https://cran.r-project.org/package=NLP), "tidyr" (https://cran.r-project.org/package=tidyr) or "tidytext" (https://cran.r-project.org/package=tidytext) packages.

To report methodologies used in studies evaluating the direct or indirect impacts of COVID-19, the study design and statistical methods employed in each study were described. Thus, the text in the articles' methods section, or the entire article's text in the case it could not be fetched, was used to search for strings related to the study design and the statistical methods used. The analysis was conducted for the whole sample at first, but also only either for studies assessing the direct or indirect impacts of COVID-19. The date of the article's publication was used in the YYYY-MM format to describe the evolution of methodologies mentioned over the analysed period. However, the month of publication was missing from some records, which did not allow for defining the date of publication in the desired format. Those records with missing data for months were not considered in the figures presenting the results on methodologies by the date of publication.

Besides, the reporting aligned with Enhancing the QUAlity and Transparency Of health Research (EQUATOR) Network guidelines was also evaluated by searching for mentions as "strobe" and "consort". This procedure intended to explore the use of The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational studies (3) and the Consolidated Standards of Reporting Trials (CONSORT) 2010 guidelines for reporting studies with an experimental design, namely clinical trials.

Mentions in the methods section of commonly used terms to indicate the study design was considered a proxy of the report of the study design adopted in that research. A pre-determined list of the most common study designs was used to search the text, including cross-sectional, cohort, case-control, ecological, case series, trials, before and after, time series, nested case-control, case-cohort, and case-crossover. Mentions of conducting a survey or applying a questionnaire were also searched for, excluding those studies where a cross-sectional study design was concomitantly reported. This option was considered to distinguish cross-sectional studies applying a questionnaire or running a survey to collect data from those using secondary data, for example, hospital admission data, rather than conducting a primary data collection.

The approach to describe statistical methods performed within the research on the direct or indirect impacts of COVID-19 was similar to that used for methodologies. Therefore, the articles' methods section was searched for terms used to identify 32 statistical methods employed in research studies, and those mentions were considered a proxy for tests used. Accordingly, the terms relative to statistical methods in a pre-determined list, detailed in the Annexes, were also sought, comprising tests used in bivariate and multivariate analyses. Welch's t-test was already considered when looking for Student's t-test, as its use depends on the latter.

Regarding data pathways, two approaches were followed: the first was to identify databases used in reports of COVID-19 impact, and the second was to explore data source types. For the first approach, several names of data sources, databases, or the entities managing them were investigated employing a technique similar to that used for methodologies. The data sources searched for in the articles' methods section are detailed in Annexes, and were defined by the authors and complemented with some identified in the data extraction for the scoping review reported in this document's chapter 2. Secondly, data source types were obtained after analysing the frequency of some text bigrams, which are pairs of words obtained after removing the punctuation and excluding commonly used words in a language. Then, the most frequent bigrams containing terms related to data source types were combined when they were similar and used to describe their utilisation.

D. Results

1. Study selection

The literature search strategy used in this review retrieved 19837 records from PubMed, published between November 2019 and November 2020. The results of the first and the second screening are detailed in the PRISMA flow diagram of Figure 2, as well as those included in the analysis.

In total, 12288 and 1300 records were excluded during the first and the second screening, respectively. Summing up the excluded articles in the first and second screening by each criterium, the majority were excluded because they had not concerned research on the COVID-19 impact assessment, followed by those which did not report empirical research and those whose records did not comprise an abstract. These three exclusion criteria were reason to exclude about half of the total number of articles.

There were 7549 records included after the first screening and 6249 after the second screening. These numbers also include case reports, mainly describing the clinical impact of COVID-19, and modelling studies, for example, those predicting the pandemic evolution (n = 776). Though these two types of studies predicted or evaluated specific forms of the COVID-19 impact, they were not used for the analysis. Moreover, it was impossible to fetch the full text of 1010 articles from the PMC, and, in the end, the text of 4463 articles was analysed. Of those, obtaining the parsed methods section of 4011 articles was possible and preferentially used to explore methodologies and data pathways employed. The full text was used to analyse the remaining 452 records whose methods section was impossible to isolate.

Among the studies analysed, 2771 records were marked as reporting research on the direct and 1692 on the indirect impact of COVID-19.

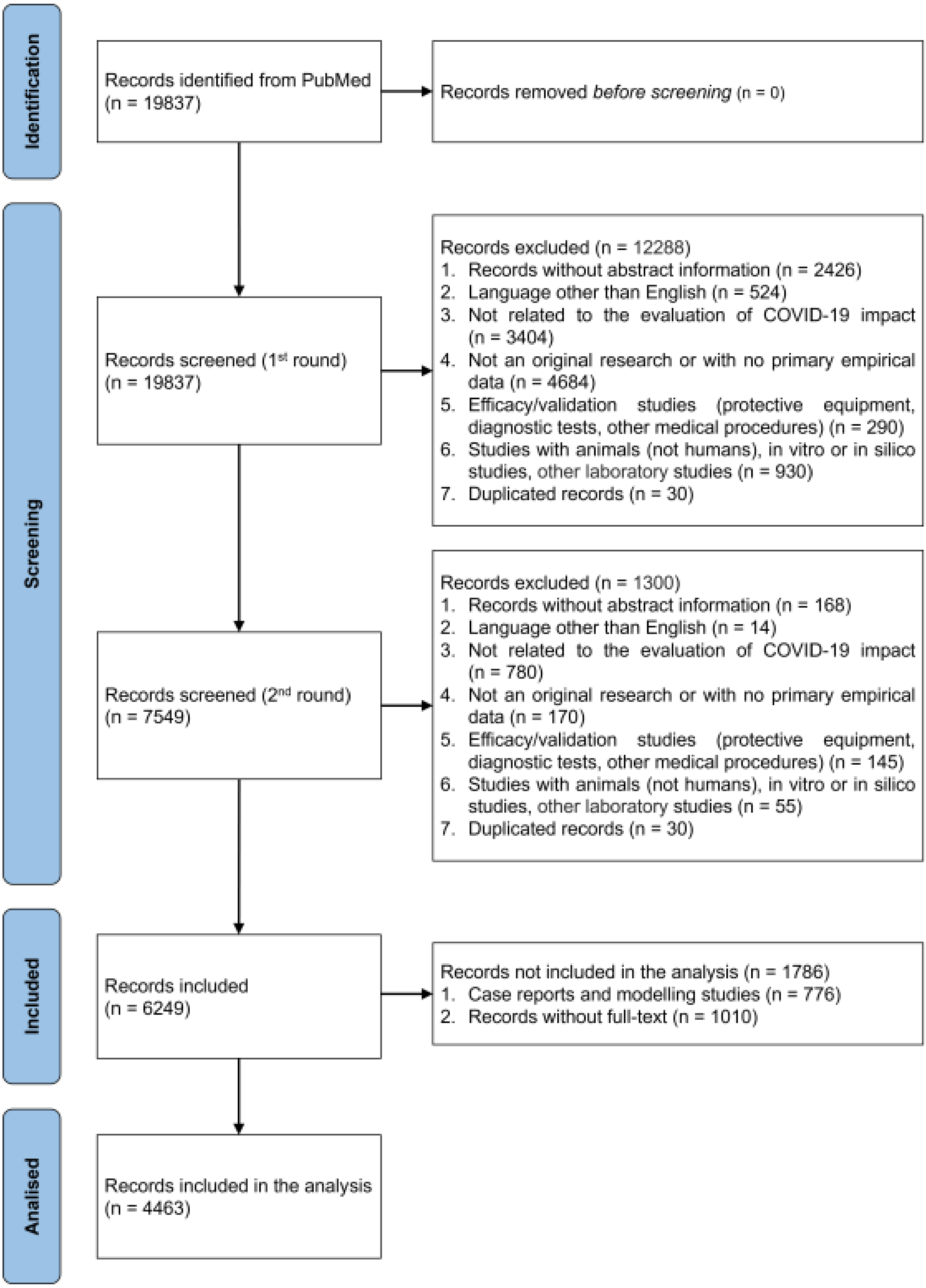

Figure 2. PRISMA flow diagram of studies selection

2. Rapid overview on reporting guidelines references

This brief topic intends to frame the results of the next sections. As the accuracy of the results obtained from the analysis strategy employed is dependent on the way the authors reported the methodologies used in their research, a rapid overview on the use of reporting guidelines for observational and experimental studies was performed. Therefore, references of EQUATOR guidelines, namely STROBE, for observational studies, and CONSORT, for experimental trials, were searched. However, they were found only in 241 articles, which correspond to 5.4% of the sample, and a very small number of health researchers supposedly using a structured tool to write manuscripts providing some information needed to do it explicitly.

3. Study designs used in research on the COVID-19 impact

Regarding the analysed information in the methods section of articles, mentions of surveys, excluding those conducted within cross-sectional studies, were the most common. They were found in 998 articles, followed by mentions of cohorts (n = 984), trials (n = 568), and cross-sectional studies (n = 536). In addition, mentions of case series (n = 125), ecological (n = 76), case-control studies (n = 43) and time series (n = 28) were well below, as shown in Table 1.

Table 1. Frequency of studies mentioning each study design, total and by type of impact

Study design	All sample n (%)	Direct impact studies, n (%)	Indirect impact studies, n (%)
Total	4463 (100%)	2771 (62.1%)	1692 (37.9%)
Survey	998 (22.4%)	367 (13.2%)	631 (37.3%)
Cohort	984 (22.0%)	793 (28.6%)	191 (11.3%)
Trials	568 (12.7%)	438 (15.8%)	130 (7.7%)
Cross-sectional	536 (12.0%)	151 (5.4%)	385 (22.8%)
Case series	125 (2.8%)	115 (4.2%)	10 (0.6%)
Ecological	76 (1.7%)	43 (1.6%)	33 (2.0%)
Case-control	43 (1.0%)	38 (1.4%)	5 (0.3%)
Time series	28 (0.6%)	6 (0.2%)	22 (1.3%)

In Figure 3, it is possible to observe that no study was included in this review published before January 2020. Accordingly, three studies published in January 2020 mentioned a cross-sectional design, whereas two included cohort mentions. So then, survey, trials and case series mentions were found each once in the studies analysed and published in the first month of 2020.

Observing articles published until March 2020, which regards the majority of the period before the pandemic state declaration by WHO, mentions of case series and cross-sectional studies, each one in six articles, and cohorts, mentioned in five, gained more emphasis than the other study designs. After March, mentions of surveys and cohorts grew faster, followed by mentions of trials and cross-sectional studies. However, the number of mentions of cross-sectional studies increased faster than trials, although, in total, fewer studies mentioned the first ones.

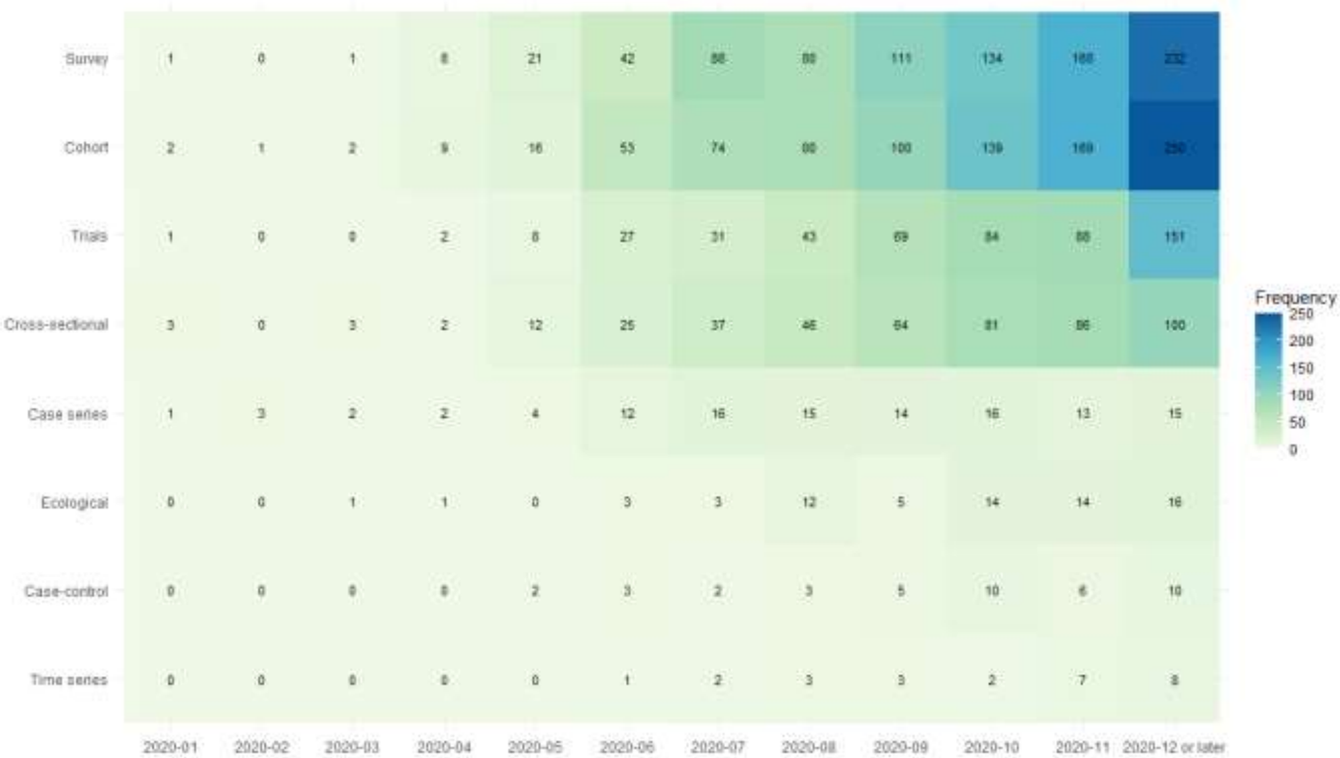

Figure 3. Distribution of study design mentions, by month

Nevertheless, different results were found when we disaggregate the sample in studies assessing the direct and indirect impacts of COVID-19, as shown in Figure 4. Therefore, studies mentioning a cohort design were the most prevalent in COVID-19 impact research during the period analysed (n = 793), whilst survey mentions were more prevalent among studies of indirect impact (n = 631). Furthermore, the evolution of the number of articles mentioning the other study designs during the months considered in the analysis also differed between studies of direct or indirect impacts. For example, the difference observed in the number of articles mentioning trials in direct (n = 438) rather than indirect impact research (n = 130) is worthy, being more prevalent among studies reporting any COVID-19 direct impact. The same could be observed for cross-sectional mentions when comparing their prevalence between two impact study groups, with the indirect impact group having proportionally more mentions (n = 385) than the direct one (n = 151). It is also relevant that cohort and trial mentions were the highest among research on the direct impact, followed by surveys and

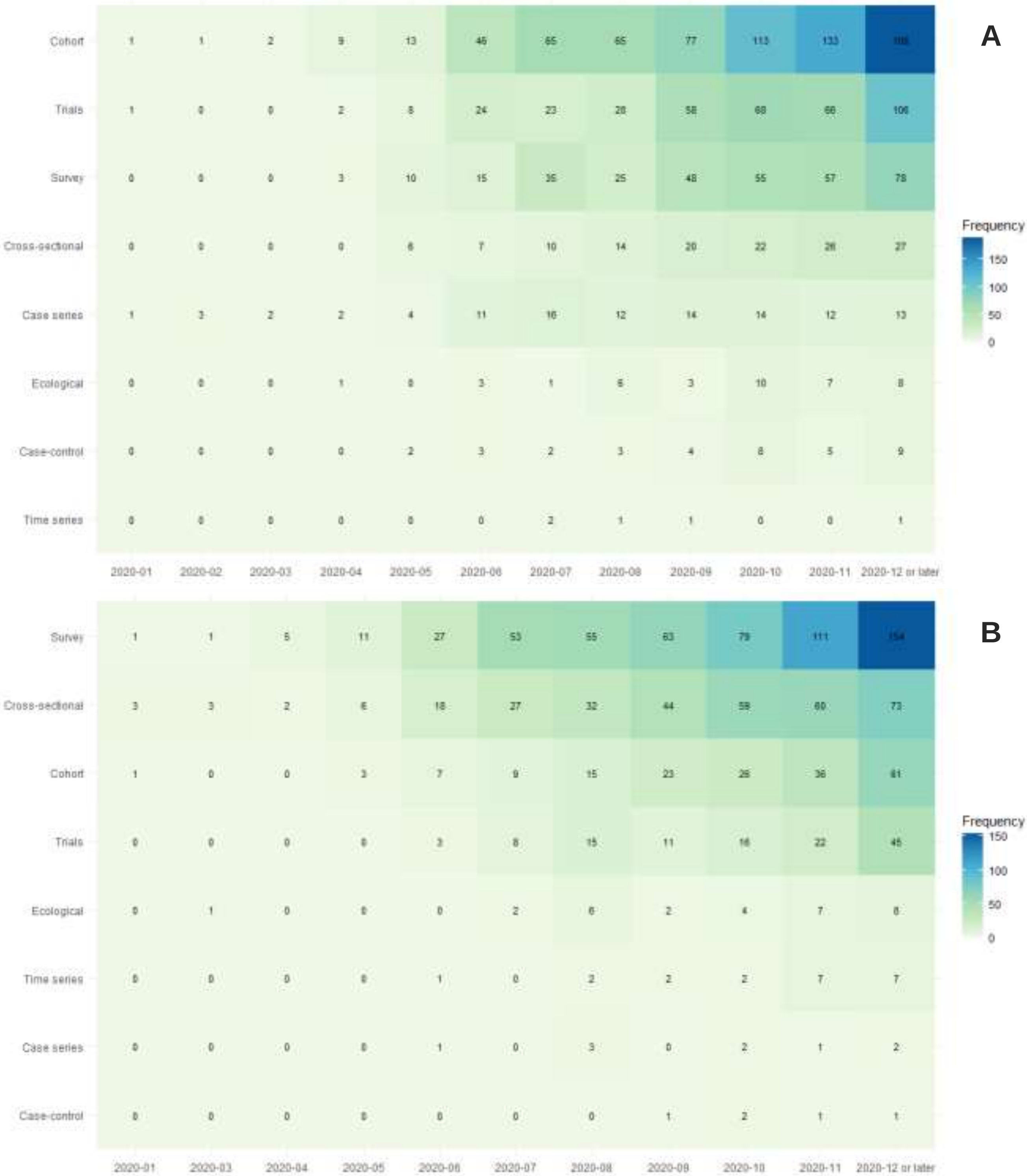

Figure 4. Distribution of study designs mentions, by month, in studies assessing the (A) direct and (B) indirect impacts of COVID-19

cross-sectional studies. These pairs exchange their positions among indirect impact studies, with surveys and cross-sectional studies mentioned more, followed by cohorts and trials.

Although mentions of case series, ecological, case-control studies and time series remained low in both direct and indirect impact groups, the relevance of case series in the former group is noteworthy (n = 115), rather than in the latter (n = 10). Additionally, even though cross-sectional studies were mentioned more often than case series, the evolution of the number of case series was observed faster. This fact confirms the trend observed when all studies were analysed, which was likely determined by mentions of case series in studies describing a direct impact assessment.

4. Statistical methods used in research on the COVID-19 impact

Regarding the statistical methods used in research on the COVID-19 impact, a comprehensive list of 33 tests was used to search for them among the methods section of studies analysed. It was possible to find mentions of 29 out of 32 tests sought, and the number of mentions of each statistical method observed is presented in Table 2 and Figure 5.

Descriptive statistics were mentioned in a significant number of articles, representing about 88% (n = 3937) of the article's sample. Separating the results by studies assessing either the direct or the indirect impact of COVID-19, descriptives were mentioned in 2453 and 1484, respectively. The student's t-test was the statistical test mentioned the most (n = 1138), followed by logistic regression (n = 1038), chi-squared test (n = 997), the Fisher's exact test (n = 606) and the Mann-Whitney test (n = 519). In addition, all the other statistical methods had lower results, each mentioned in less than 400 articles. Between the statistical methods mentioned more often, hypothesis or elementary tests were more prevalent than regression analysis techniques. It is also interesting to point out that the number of *post hoc* tests mentions starts only in April 2020, when a method with which these tests are used was also found, in this case, ANOVA.

Among the regression methods mentioned the most, logistic regression was mentioned more often than linear regression. This fact lets us foresee a higher use of categorical variables as the dependent variable rather than continuous ones. On the other hand, other regression analysis techniques had lower expression in the articles measuring COVID-19 impacts or started being mentioned in articles published later. For example, mentions of Cox regression or the Kaplan-Meier method were scarcely identified during the first five months analysed. However, they had a significant increase in June 2020, likely due to the follow-up over a given period these techniques require.

When the results were disaggregated by the type of impact assessed in each study, it is possible to observe that the importance of mentions of some statistical tests differs, as presented in Figure 6 and Figure 7. For example, the number of logistic regression mentions differs between the most prevalent statistical methods in studies of each type of impact. Accordingly, logistic regression was the most mentioned statistic among studies measuring the COVID-19 direct impact. In contrast, among indirect impact articles, it occupied only the third position of the techniques mentioned more often. Moreover, survival analysis methods, namely Cox regression or Kaplan-Meier, had a much lower relevance among research on COVID-19 indirect impact than those conducted to evaluate any direct impact. Finally, regarding correlation methods, the number of mentions of Spearman's correlation is higher than Pearson's in studies of direct impacts, whereas, in indirect impact research, the contrary is observed.

Table 2. Frequency of studies mentioning each statistical method, total and by type of impact

Statistical methods	All sample n (%)	Direct impact studies, n (%)	Indirect impact studies, n (%)
Total	4463 (100%)	2771 (62.1%)	1692 (37.9%)
Descriptive statistics	3937 (88.2%)	2453 (88.5%)	1484 (87.7%)
Student's t-test	1138 (25.5%)	718 (25.9%)	420 (24.8%)
Logistic regression	1038 (23.3%)	739 (26.7%)	299 (17.7%)
Chi-square test	997 (22.3%)	592 (21.4%)	405 (23.9%)
Fisher's test	606 (13.6%)	495 (17.9%)	111 (6.6%)
Mann-Whitney U test	519 (11.6%)	390 (14.1%)	129 (7.6%)
ANOVA	374 (8.4%)	194 (7.0%)	180 (10.6%)
Linear regression	342 (7.7%)	170 (6.1%)	172 (10.2%)
Cox regression	289 (6.5%)	286 (10.3%)	3 (0.2%)
Post hoc tests	264 (5.9%)	145 (5.2%)	119 (7.0%)
Wilcoxon's test	249 (5.6%)	187 (6.7%)	62 (3.7%)
Spearman's correlation	191 (4.3%)	144 (5.2%)	47 (2.8%)
Pearson correlation	178 (4.0%)	108 (3.9%)	70 (4.1%)
Kruskal-Wallis test	167 (3.7%)	107 (3.9%)	60 (3.5%)
Kaplan–Meier method	162 (3.6%)	154 (5.6%)	8 (0.5%)
Log-rank test	140 (3.1%)	137 (4.9%)	3 (0.2%)
Poisson regression	106 (2.4%)	52 (1.9%)	54 (3.2%)
Generalised linear model	43 (1.0%)	31 (1.1%)	12 (0.7%)
Binomial regression	40 (0.9%)	27 (1.0%)	13 (0.8%)
Principal component analysis	30 (0.7%)	16 (0.6%)	14 (0.8%)
ANCOVA	30 (0.7%)	11 (0.4%)	19 (1.1%)
McNemar's test	21 (0.5%)	9 (0.3%)	12 (0.7%)
Z-test	19 (0.4%)	8 (0.3%)	11 (0.7%)
Kendall's test	11 (0.2%)	6 (0.2%)	5 (0.3%)
Friedman test	10 (0.2%)	8 (0.3%)	2 (0.1%)
Cramér's V	9 (0.2%)	3 (0.1%)	6 (0.4%)
MANOVA	7 (0.2%)	0 (0%)	7 (0.4%)
K-means clustering	7 (0.2%)	3 (0.1%)	4 (0.2%)
Binomial test	4 (0.1%)	4 (0.1%)	0 (0%)
Cochran's Q test	2 (0%)	2 (0.1%)	0 (0%)
Contingency coefficient	1 (0%)	0 (0%)	1 (0.1%)

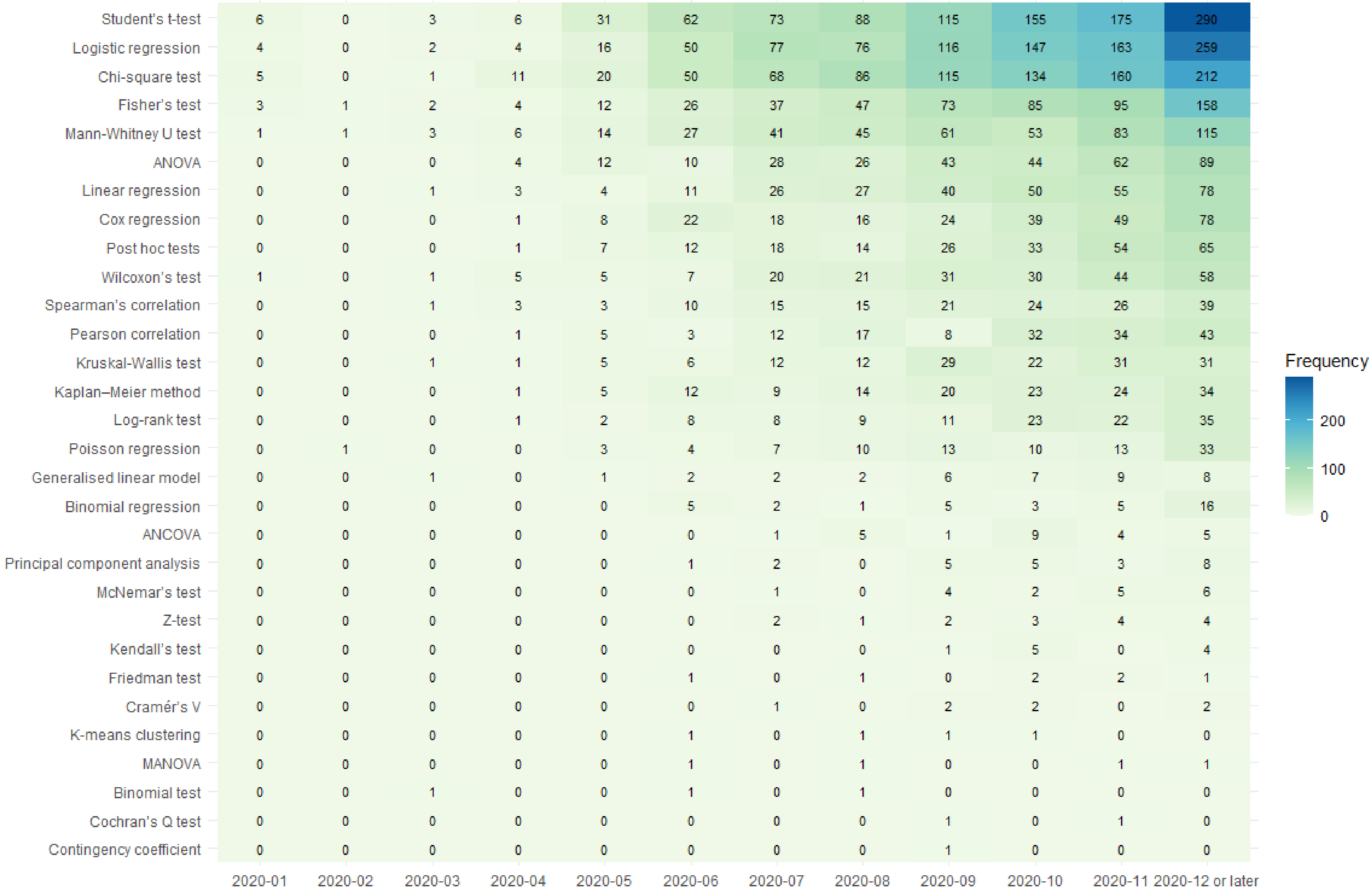

Figure 5. Distribution of statistical methods mentions in COVID-19 impact research, by month

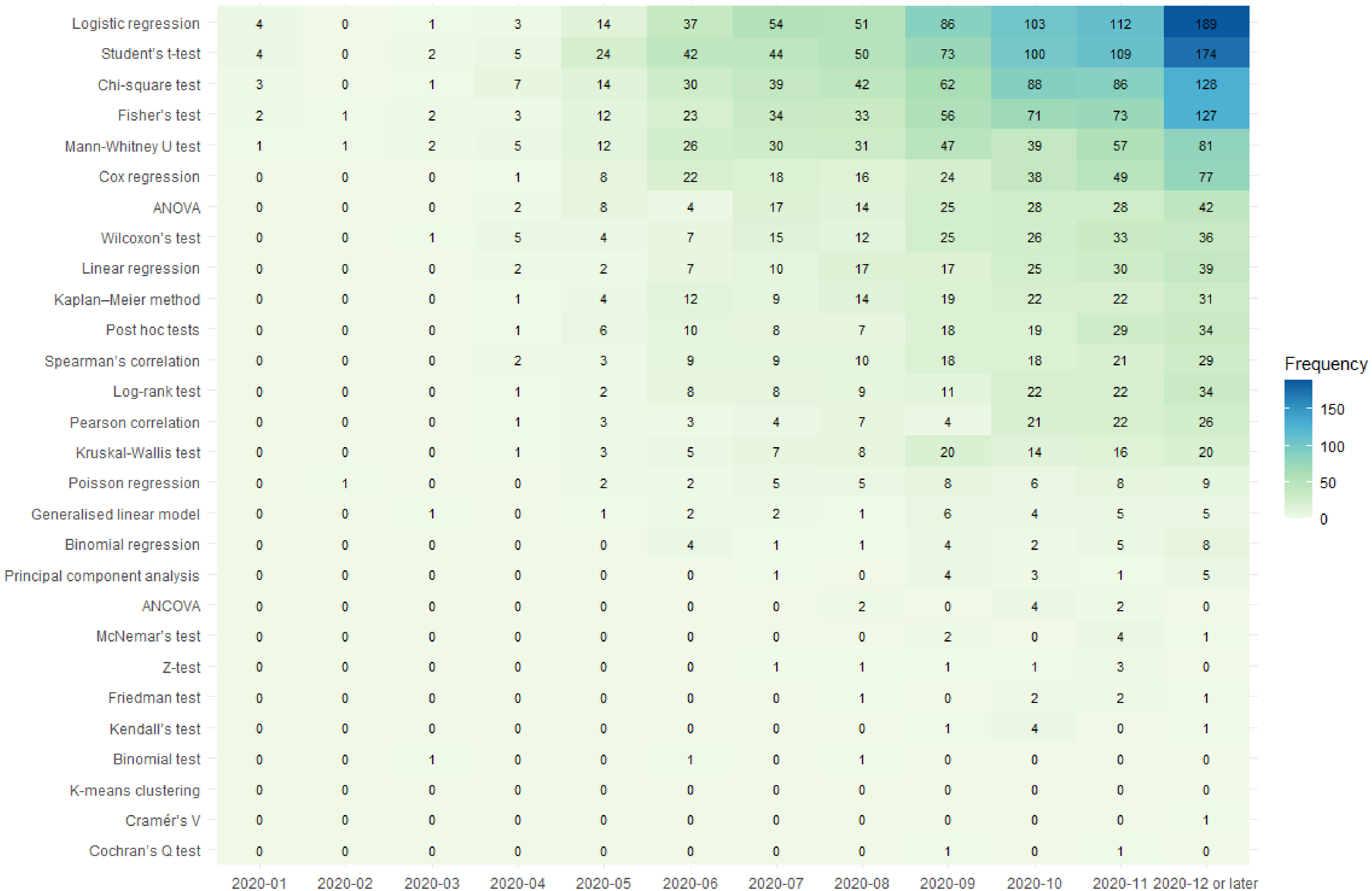

Figure 6. Distribution of statistical methods mentions in COVID-19 direct impact research, by month

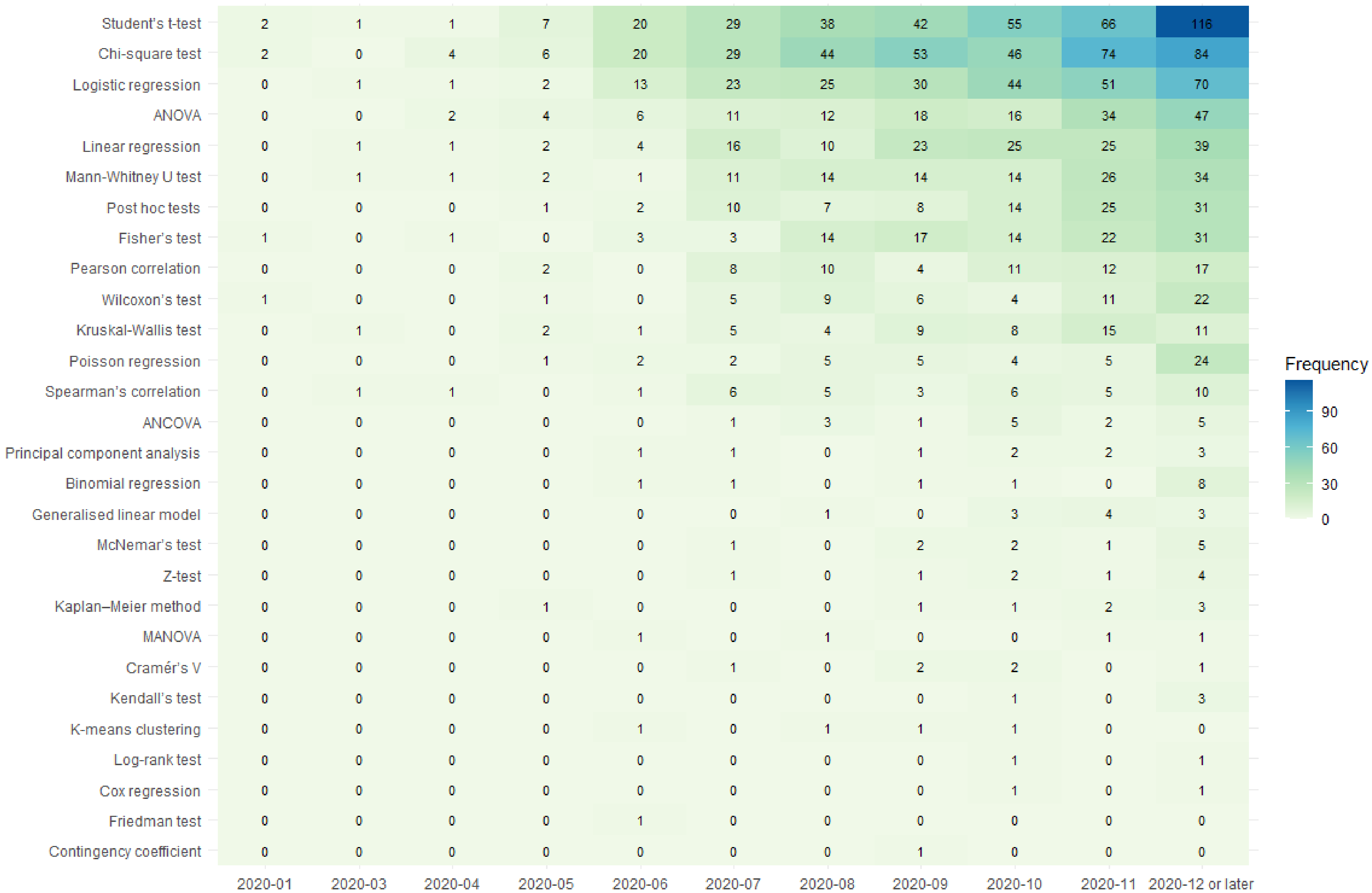

Figure 7. Distribution of statistical methods mentions in COVID-19 indirect impact research, by month

5. Data pathways used in research on the COVID-19 impact

Regarding data pathways, the same approach as for methodologies was followed to identify different types and which specific data sources were used in COVID-19 impact research. Nevertheless, this approach was reinforced by analysing bigrams and looking at which data types could be searched to make the analysis more accurate. Therefore, Figure 8 represents the relevance of each data type searched for according to the number of mentions found in COVID-19 impact research.

Data obtained by conducting a survey or applying a given questionnaire appear as the most relevant in research assessing COVID-19 impact (31.5%, n = 1408), followed by data obtained from hospital admissions (15.7%, n = 701), from hospital diagnosis codification (3.6%, n = 162), census data (2.4%, n = 107), hospital administrative data (1.2%, n = 52) and data based on zip codes (0.9%, n = 40).

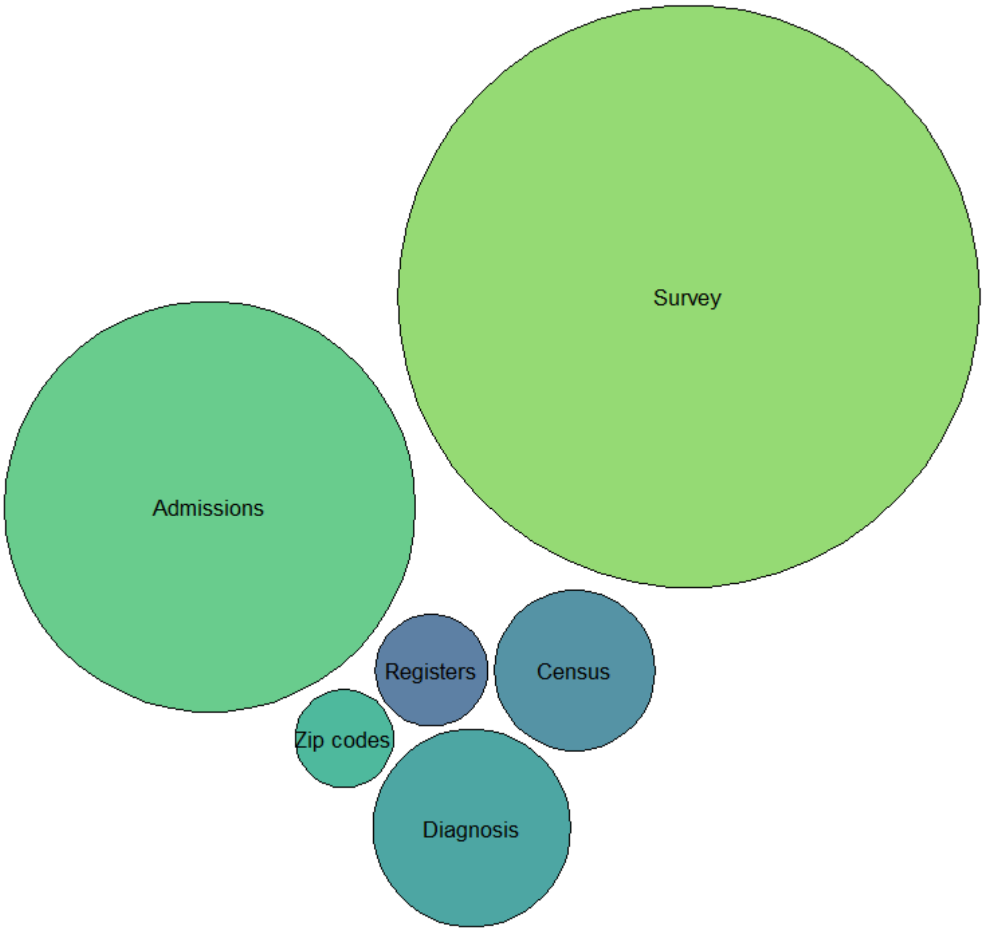

Figure 8. Types of data sources identified in COVID-19 impact research

In what concerns specific data sources, Figure 9 represents the hierarchy of the number of data sources mentioned using the list we searched. Thus, articles mentioning data sources with diagnosis codes according to the International Classification of Diseases (ICD) (4.6%, n = 205). However, other sought data sources did not exceed 100 mentions, as the COVID-19 Data Repository managed by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University, the second mentioned more often (2.0%, n = 90). Moreover, other data sources mentioned with significant representativeness were WHO COVID-19 data (1.4%, n = 63), data from the World Bank (1.1%, n =

49), Worldometer (1.0%, n = 45), CDC COVID-19 data (0.9%, n = 38) and Our World in Data (0.7%, n = 30). It is also noteworthy the relevance of data from the National Aeronautics and Space Administration (0.5%, n = 22), which manages data on atmosphere pollution, and from the National Oceanic and Atmospheric Administration, United States, which is mainly devoted to producing weather data (0.4%, n = 19).

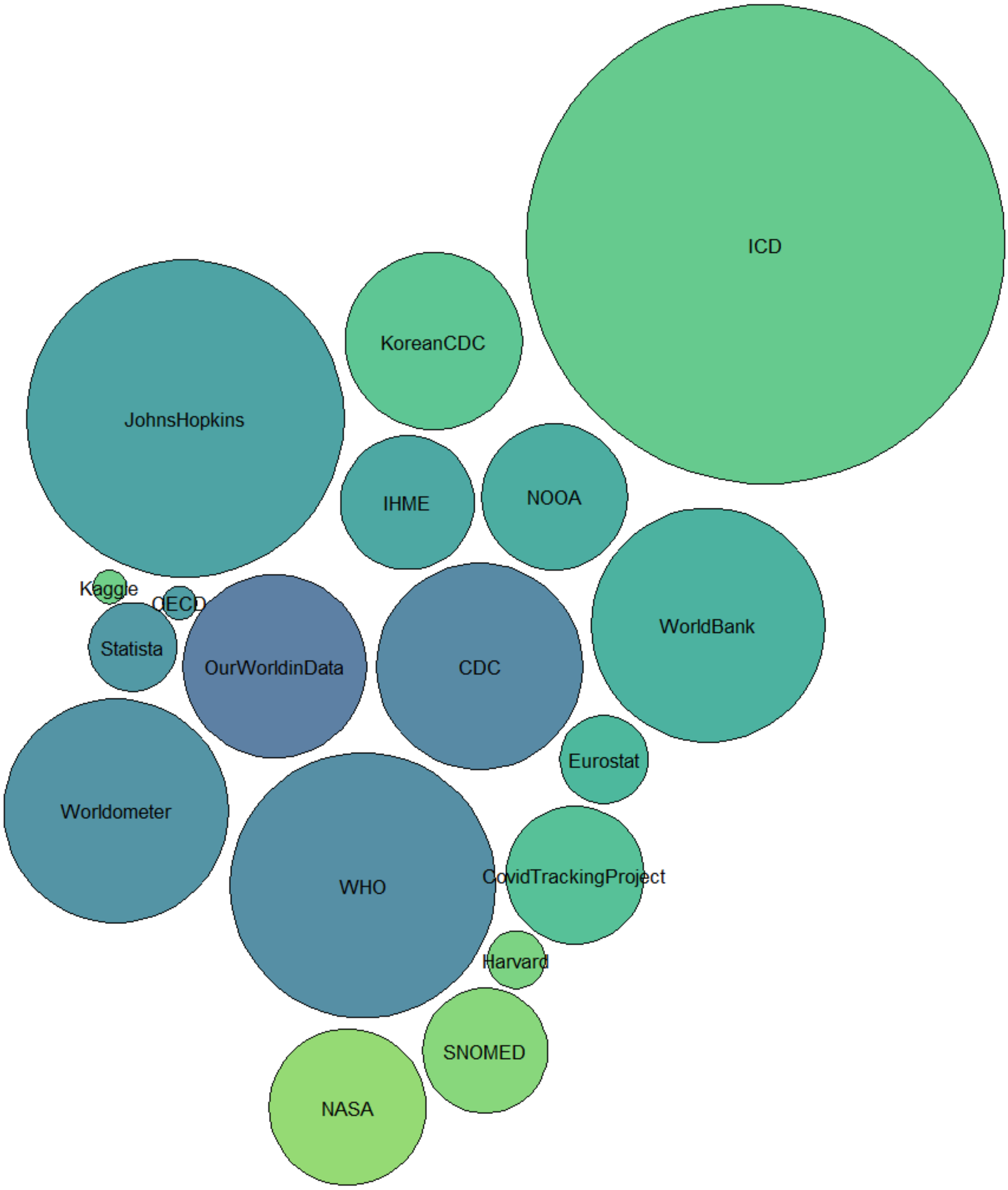

Figure 9. Data sources identified in COVID-19 impact research

E. Discussion and implications of this study

This study was conducted within the WP5 of the PHIRI project and aimed to explore the methodologies and data pathways used in articles reporting on the direct and indirect impacts of COVID-19. By using a text-mining approach based on the search for specific keywords and terms related to the study designs, statistical methods and data pathways employed in the analysed research, this study presented the number of articles mentioning each. In addition, the results were considered as a proxy of their representativeness among COVID-19 impact research. The main findings suggest a higher adoption of surveys, cohorts, trials, and cross-sectional studies in research on COVID-19 impacts, though their relevance differs among studies assessing direct or indirect impacts. Regarding the statistical methods used to conduct the analysis and considering only the most mentioned ones, results suggest that elementary techniques were predominantly used, such as the student's t, chi-square, Fisher's exact and Mann-Whitney tests, compared to regression analysis, such as logistic or linear ones. Finally, data were mainly collected through surveys or questionnaires, followed by data obtained from health information systems, namely hospital admissions, diagnosis codes or administrative data. Besides data primarily collected within studies deploying surveys, most mentioned data sources were derived from medical diagnosis codes using the ICD and surveillance data from the COVID-19 Data Repository from Johns Hopkins University and WHO.

Cohort studies and surveys were the designs most identified among studies assessing a direct and indirect impact, respectively. This pattern denotes a preference for longitudinal studies to describe the direct impacts of COVID-19 and non-longitudinal designs to assess the indirect impacts, even though the representability of the population was not always assured. Facing a new and unpredictable disease, researchers were asked to increase and share knowledge about the transmission of a new pathogen and the susceptibility to and severity of a new disease, to make it timely available for frontline clinicians (4). Cohort design was probably most used to describe the evolution of the infection with SARS-CoV-2 and its morbidity and mortality outcomes, as well as accounting for their associated explanatory variables. Although mentions of cohort studies were the most prevalent among studies of direct impacts, case series were mentioned more often during the pandemic beginning. A potential reason for that could be because this study design can use data readily available and include smaller samples to describe trends and raise hypotheses to be further and comprehensively evaluated (5). Even though this work did not consider case reports in the analysis, case series were included as some used administrative or diagnosis codes available from hospital information systems. However, the increase in the publication of case reports during the pandemic is notorious and observed in PubMed using "case reports" as a publication type filter, compared to the years before, when their publication had been decreasing.

However, with three years of the pandemic, a growing body of literature has increased the attention to the long-term impacts of COVID-19, either a consequence of having gotten infected and developing long-covid or indirect impacts, such as poorer mental health (6), well-being, quality of life, healthcare utilisation (7) or other impacts on social determinants of health, namely employment or social environment. Unfortunately, the period filter in the search strategy restricted the availability of studies published after one year of the pandemic beginning. Nevertheless, it would be necessary to confirm if longitudinal studies to evaluate the indirect impact of COVID-19 in the medium- or long-term have already described these effects enough, establishing repeated follow-ups to monitor population health and promptly address identified adverse effects.

The number of articles mentioning surveys or questionnaires allows us to foresee that almost one-fourth of studies adopted data collection strategies to gather primary data. Although the COVID-19 pandemic created rapid and disruptive impacts on the human population, the number of evidence published since the crisis began and the number of surveys mentioned suggest that the academy rapidly adapted data collection during periods of physical distance decreed by governments to mitigate outbreaks. However, as most data was remotely collected, other limitations were added to those already associated with this type of data collection. For example, problems in developing trust with the participant, validation of tools to be applied online or by a telephone interview, and population representativeness affected by poor access to technologies are some limitations which can difficult an accurate frame of some population subgroups, especially those in disadvantaged situations or less likely to participate in surveys (8,9). This fact raises additional concerns and demands strategies to face these limitations during data collection, and specific analysis approaches to guarantee that inequities are well described and addressed (10). Moreover, it is still an opportunity to improve the mean as researchers collect data remotely and potentially reach people in situations that have been difficult for them to participate in so far.

Regarding the statistical methods, references to descriptive statistics dominated the analysed research. This is an expected result because describing sample characteristics is a conventional research practice. However, it is still unexpected why not the number of articles mentioning descriptive statistics was not closer to the analysed sample size. Another study exploring the statistical methods used in research using the Canadian Community Health Survey (CCHS) dataset found a relatively higher proportion of studies reporting descriptives (97.7%) (11), and a review of public health literature reported its use in more than 95% of articles (12). However, another study reviewing biomedical informatics literature had a lower result (78%) (13). Nevertheless, this result can be a consequence of either the way authors reported methods usage, or the strategy used to find terms of interest related to descriptive statistics.

Among other statistical methods, elementary statistics, namely, student's t-test, chi-square, Fisher's exact, or Mann-Whitney tests, were identified more frequently than regression techniques. However, if only the two most mentioned methods, the student's t-test appeared in the first position and logistic regression in the second. Furthermore, literature following a similar approach found an expressively higher frequency of references to regression analysis rather than to elementary statistics (11). COVID-19 was a new disease when the analysed research was conducted, but the differential direct impact of this infection in people with different social or health profiles was noted early. These findings likely resulted from conducting regression analysis which permitted analysing outcomes while accounting for the modification or confounding effect of factors, such as comorbidities or social conditions. Considering the advantages of regression analysis in evaluating risk factors for determining the outcome and accounting for other explanatory or confounding variables, its use should be promoted rather than only elementary statistics. Previous literature regarding its use in public health research even advocated for including this method in biostatistics education for graduate public health students (12). Of course, data collection and its structure will determine the possibility of using or not using regression analysis. Therefore, the availability of routinely collected data and mechanisms allowing its use steadily in case of a new emergency or the designing of study methods that allow regression analyses would be recommended in the future.

Routinely collected health data, such as diagnosis codes or other administrative data provided by hospital information systems, can indeed be used to promptly monitor the impact of a new pandemic. However, this type of data source depends on the quality of codification, which can be impaired in a new crisis due to the absence of guidelines for codifying new diseases or conditions. Therefore, international health organisations shall have procedures to rapidly disseminate new protocols for codifying new diseases or conditions, and healthcare shall guarantee prompt action on implementing any protocol endorsed.

Some health-related impacts most commonly mentioned in the literature analysed were already present before the COVID-19 pandemic at a low or high scale. For example, the role of some medical conditions, isolated or as part of multimorbidity, such as hypertension, cardiovascular, diabetes, or chronic respiratory diseases (14–16), obesity (16,17), or other social determinants of health, such as older age (17) or socioeconomic deprivation (18) were described as risk factors for getting infected or having poorer outcomes in COVID-19 patients. These conditions also result from otherpublic health problems, such as widespread malnutrition, diet-related (and avoidable) diseases or air pollution related to urban living, and other vulnerabilities, such as unemployment, ageing, or ethnicity. This fact highlights the syndemic parallel referred to by the editor-in-chief in The Lancet, also advocating for the need to manage these problems together with mitigating the direct and indirect impacts of COVID-19 (19). Thus, a structural and effective approach would be necessary to minimise these problems before the next health crisis. On the contrary, the same co-occurrence of these problems must be acutely managed while also dealing with highly impacting, known, or unknown events in the future, such as the COVID-19 pandemic.

The information summarised can be relevant for guiding the design of research practices on COVID-19 impact monitoring or to identify research needs to prioritise in future pandemics. In addition, future capacity-building exercises should be promoted and include considerations herein proposed to achieve effective implementation. Thus, it is expected that identified differences in the methodologies or data pathways can be addressed after recommendations resulting from this *Roadmap*. Furthermore, data collected throughout the pandemic also can be different across countries due to the established health information systems practices or the pandemic phase. However, it is also expected that this exercise can guide the collection of comparable and comprehensive data to allow harmonised comparison of outcomes and indicators of interest.

Although the authorities' response has contributed to modifying the magnitude the COVID-19 pandemic, this crisis has exhibited the ability to originate disruptive challenges to the population at a sub-national, national, and European level. Nevertheless, revisiting the pandemic course, as done in this report and periodically in the future, can be crucial to review the signs of progress in the methodologies used to gather the evidence and new or known direct or indirect impacts of COVID-19, and to identify gaps in research or improving opportunities.

1. Limitations

This chapter aimed to explore methodologies and data pathways used in research to measure the COVID-19 impact. For that, an automated analysis strategy was employed, based on the text analysis of a sample of articles on the field and considering references of keywords of interest as a proxy for their use. However, this type of approach could have led to inaccurate results, due to the keywords selected to search for. Moreover, finding a mention of a given keyword could have been due to some contextualisation made by authors in some situations. For example, authors could have mentioned the term "cohort" to contextualise or compare their work with another research following that study design. Still, limiting the analysis to the methods section could have minimised this bias. In addition, reporting practices can also differ among authors, and even though guidelines for writing manuscripts have been endorsed, for example for observational (3) or experimental studies (20), they could not have been widely adopted yet, as foresight by the number of articles referencing them. This was not the first time a similar strategy was used to explore the literature, for example, on statistical methods (11), and yet, it can work to identify trends on what is sought. Further studies using similar approaches can use the work herein disseminated and revise the search strategy, namely keywords list, and improve it to identify different ways of reporting the same methodology or data pathways to better identify them.

The current study followed wide criteria for considering studies assessing any COVID-19 impact, leading to the inclusion a significant number of articles without a control group to compare the situation before the pandemic. For example, studies assessing the indirect impact of the pandemic in mental health could be compared with data before this crisis when it was available, but when it was not a comparison was impossible. Studies with no control group might have limited internal validity and hinder the ability to draw causal inferences. However, given the sudden emergence and rapid spread of COVID-19, it is understandable that many researchers had to conduct studies with limited comparison groups. Future research should consider including studies with control groups and explore methodologies to address the lack of pre-pandemic data, such as utilising historical controls or employing statistical techniques like propensity score matching to create comparable groups.

Another limitation of this study is that the search was restricted to PubMed, used only records in English language, and was not systematic, which may limit the comprehensiveness of the literature included. While PubMed is a widely used database with extensive coverage of medical and health-related literature, other databases, such as Scopus, Web of Science, or Embase, could provide additional relevant articles. The information reported in languages other than English can also have relevant information which could complement that herein analysed. Moreover, a systematic review would have ensured a more rigorous and transparent process in identifying and selecting studies, for example, during screening stage. To minimise potential biases and increase the generalisability of the findings, future research should consider utilising multiple databases, including articles written in other languages that English, and conducting a systematic review to provide a more robust understanding of the methodologies and data pathways in COVID-19 impact research.

The criteria used for the publication date in this study may have limited the ability to capture the full scope of the methodologies and data pathways utilised in COVID-19 impact research, as it might have masked the actual date when the study was conducted or initially made available. The rapidly evolving nature of the pandemic has resulted in the emergence of various preprint platforms, allowing for quicker dissemination of research findings. Therefore, future studies should consider including preprints and adjusting the publication date criteria to capture a more comprehensive and up-to-date overview of the methodologies and data pathways used in COVID-19 impact research. This approach would help identify trends in research practices over time, as well as highlight potential areas for improvement in the design, implementation, and analysis of future studies.

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I. Chapter 2 – subtask 5.1.2

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DIRECT IMPACT OF COVID-19 PANDEMIC ON POPULATION MORBIDITY, SEVERITY AND MORTALITY: A RAPID SCOPING REVIEW AND A SURVEY

COVID-19 crisis effects impacted all health areas more than any other communicable disease. The pandemic disrupted the access and provision of health services tackling with an unexpected load of patients. This direct impact is addressed in this subtask. However, it also escalated the overall mortality and burden of disease through its impact on non-communicable diseases (1). This indirect impact has also been quantified in terms of the economic burden on healthcare resource utilisation (2) and it is analysed in the report for the subtask 5.1.3.

Between January 2020 and December 2021, the full death toll directly or indirectly associated with the COVID-19 pandemic ("excess mortality") was estimated at 14.9 million globally (13.3 million to 16.6) (3). The weekly report from the European Centre for Disease Prevention and Control (ECDC) of February 2023 informed that there were 535,143,050 COVID-19 cases and 6,328,694 deaths. At the moment of updating this report (at the end of week 7, 2023), pooled rates of case notification (all-age and among those aged 65 years and above), hospitalisations, ICU admissions and COVID-19-related deaths have declined, currently remaining at the lowest levels observed in the past 12 months (4).

Timely implemented non-pharmacological interventions (NPIs) have shown wide variation in COVID-19 cases and associated deaths among countries. Up to 25 April 2020 Hong Kong had among the lowest incidence and mortality (135.5 and 0.5 per 1,000,000 population) in the world (5,6). However, the late adoption of measures, such as the strict NPIs (movement restriction, physical distancing, and isolation for citizens) implemented in Spain, did not prevent Spain to become one of the countries most affected by the COVID-19 pandemic (7). During the first epidemic wave, surveillance focused on quantifying the magnitude and the escalation of a growing global health crisis. Basic indicators, such as the number of cases or rates of new cases and deaths, were used to assess risk. Then, the scientific community took action by evaluating figures and identifying vulnerable population groups, using indicators measuring the direct impact caused by the COVID-19 disease.

A. Literature study

Global scientific efforts to tackle the COVID-19 epidemic have produced a significant increase in the literature body, as reflected by the search engine *PubMed,* which counted almost 350,000 results referencing COVID-19 (30/03/2023). Thus, it urges to summarise which indicators were used in the literature to collect information measuring the disease's direct impact on the population health. Complementarily, it is a matter of interest to know how the indicators implemented in scientific studies were also used by health authorities.

B. Aim

The work carried out in this subtask aimed at synthesizing the knowledge on assessing the direct impact of the COVID-19 pandemic on population health (i.e., COVID-19 severity and COVID-19-associated morbidity and mortality). The synthesis was based on a **scoping and rapid review methodology** that allowed mapping a large and heterogeneous body of available literature. Our specific aims were:

- To identify the health indicators used to evaluate the direct impact of COVID-19 by describing how they were calculated in the scientific literature.
- To identify the types of available data sources used to estimate morbidity, severity and mortality associated with COVID-19 impact.
- To compare the health indicators reported in the COVID-19 literature, focusing on differences in their implementation.
- To investigate, whether health indicators allow for comparison across studies and countries.
- To point out what indicators identified in the scoping review were also used in national policy monitoring documents or decision tools.

C. Methods

1. Protocol and registration

The study protocol followed the "Preferred Reporting Items for Systematic Reviews and Meta-analysis Protocols (PRISMA-P 2015) Statement" (8). The study protocol was registered within the Open Science Framework in October 2021 (https://osf.io/ac8xd). An updated version of the protocol including amendments and changes from the original version was developed to include suggestions from the working group (Appendix 1) (https://osf.io/4q5r6; DOI: 10.17605/OSF.IO/T32EY).

2. Eligibility criteria

The research question was based on the Population, Concept and Context (PCC) strategy, establishing:

- **P**opulation: general population, patients, outpatients, hospitalised patients, residents in long-term care facilities (LTCF) and older population.
- **C**oncept: health indicators related to the direct impact of COVID-19 (e.g. incidence/prevalence, hospitalisation, ICU admission, mortality or basic reproductive number).
- **C**ontext: representative samples of countries, regions or administrative units; multicentre studies; big data; measures of health during the pandemic; articles published between January 2020 and June 2021.

Detailed eligibility criteria have been developed according to the following: participants, study design, types of data, types of exposures and outcomes of interest, setting, date and language of publication.

a) Participants

Studies involving the general population, outpatients, hospitalised patients, residents in LTCF and older population were selected.

b) Study design

Observational studies applying cohort, case-control, cross-sectional or ecological designs were included.

c) Types of data

Indicators were drawn from secondary data sources (patient registries, disease registries, primary care databases, pharmacy data or cancer registries) together with other health reporting data (insurance claims). In addition, indicators from epidemiological surveillance of COVID-19 (i.e., primary data sources), as well as *ad hoc* research databases were also searched.

d) Settings

Hospital indicators, such as hospital and/or ICU admission, need for mechanical ventilation or case fatality rate, were not considered for this rapid scoping review if they referred to a single centre. However, reference centres receiving samples from others or testing their community were included.

Long-term care facilities and homes for elderly people assessing COVID-19 positivity, severity and mortality were also considered.

e) Date of publication (month/year)

Eligible studies were published from January 2020 to June 2021, which corresponds to the first 18 months of the pandemic.

f) Language of publication

Studies were limited to those published as peer-reviewed journal articles written in English with an available abstract.

3. Information sources and search

PubMed and EMBASE bibliographic databases were searched on October 29, 2021 and the WHO COVID-19 database on November 2, 2021. The PRESS statement was followed to check the appropriateness of electronic literature search strategies (**List 1**) (9). The search strategies were peer-reviewed by an experienced librarian from the Spanish National Health Science Library. It was adapted for using the specific search tools available for each database. Filters developed by expert documentalists from the United States National Library of Medicine were included in the search strategies, such as the COVID-19 filter (see **Appendix 2** for the search strategies used for each database).

List 1. Draft for core search in sequential steps

1. Disease definition: COVID-19 and SARS-CoV-2 terms
2. Study design
3. Indicator: basic/time-varying reproduction number
4. Indicator: incidence/prevalence
5. Indicator: test/positivity rate
6. Indicator: mortality
7. Indicator: severity
8. Sample: general population, COVID-19 inpatients
9. Identification of exclusion criterion: RCT and related terms
10. Identification of exclusion criterion: case report and related terms
11. Identification of exclusion criterion: psychological indicators and related terms
12. Joining indicators maximising the search: (#3) OR (#4) OR (#5) OR (#6) OR (#7)
13. Joining definitions limiting the search: (#1) AND (#2) AND (#8) AND (#12)
14. Applying exclusion criterion: NOT preprint
15. Applying exclusion criterion: RCT

16. Applying exclusion criterion: case reports
17. Applying exclusion criterion: psychological indicators

4. Selection of sources of evidence and data charting process

a) Title/abstract screening phase

Two researchers from the leading institution ISCIII organised tasks (Team 1), obtained bibliographic references and assigned tasks to 14 collaborators from 10 partner institutions in Europe (Team 2). All citations retrieved from the peer-reviewed literature search were exported to the Rayyan systematic review management software (Ouzzani et al., 2016) (https://rayyan.ai/). A pilot screening of retrieved studies was performed by Team 1 in a sample of 5% of total records. Rayyan was used to detect and remove duplicate citations, as well as accept or exclude titles and abstracts (see **Box 1**). Team 1 split the role of the first reviewer for the screening phase. The role of the second reviewer was distributed among Team 2 (**Appendix 3**) and each member reviewed respective records. Total records identified through the search strategy were divided and reviewed by Team 1 independently. Then, records were rated as “included”, “excluded” and “maybe” using the on-line Rayyan tool. Discrepancies (“conflicts” label in Rayyan tool) and “maybe eligible abstracts” were discussed until a consensus was achieved between the respective reviewers from Team 1 and Team 2 (**Figure 1**).

The exclusion criteria detailed in the Box 1 were adopted to guide the selection of references whose information would fit the purpose of this rapid scoping review.

Box 1. Reasons for exclusion from 'Title/abstract screening phase'

1. Not original research nor grey literature (i.e., editorials, protocols, or no original results).
2. Unrelated topics (e.g., an indirect impact indicator).
3. Not population-based studies (representative individuals of the general population). However, nursing homes, homes for the aged and inpatients (hospitalised patients) were included.
4. Subpopulations (e.g., paediatric patients, patients having a condition without comparison with general population, pregnant women, healthcare workers, etc.). However, elderly were included.
5. Duplicates.
6. Prognostic studies (i.e., forecasting studies, predictive models, prospective studies, projections and predictions, foresight, future).
7. Conference abstracts.

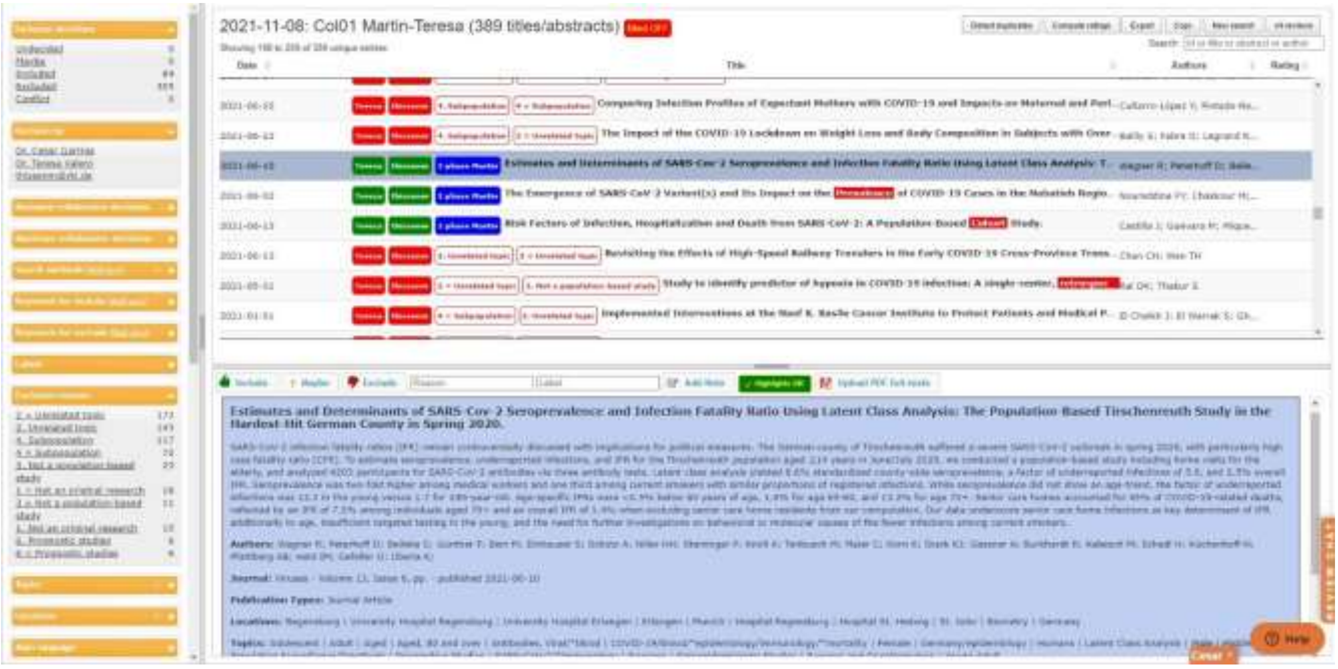

Figure 1. Example of title/abstract screening phase. Screenshot of Rayyan tool.

b) Full-text reading phase

The 5 researchers from the ISCIII jointly developed a data-charting form to determine which variables to extract from the studies (**Appendix 4**). Team 1 organised bi-lateral meetings with their counterparts from partner institutions to practice paper selection and data extraction using the data-charting form. A sample of 10 papers selected from the screening phase was used for that training. This pilot test ensured that all relevant data were gathered correctly. After that, the remaining papers chosen for the full-text reading phase were distributed among Team-2 collaborators for a further selection of studies. **Box 2** presents the exclusion criteria applied for this phase. Doubtful papers were read by peers to take a decision about their inclusion.

Box 2. Exclusion reasons for the 'Full-text reading' phase

1. Not population-based studies.
2. Studies not considering health indicators.
3. Studies not containing information on health indicators' calculation*.
4. Studies not containing information of data sources used to get data for calculation.
5. Unrelated topics (e.g., an indirect impact indicator.
6. Subpopulations (e.g., paediatric patients, patients having a condition without comparison with general population, pregnant women, healthcare workers, students, US veterans, etc.). However, elderly were included.
7. Not original research nor grey literature nor conference abstract (i.e., editorial, protocol, or no original results)
8. Clinical trials or intervention studies.
9. Qualitative studies.
10. The study is a continuation of a previous study. Studies were selected among those providing more information regarding health indicators. If there were several studies related but using at least one different indicator, all those papers were included.

***** For studies not reporting any calculation of indicators. Some papers included indicators calculated on external websites. Some of the websites providing their calculation on indicators were:

- https://www.worldometers.info/ (Worldometer Team)
- https://coronavirus.jhu.edu/map.html (John Hopkins University)
- https://ourworldindata.org/ (University of Oxford)

c) *Indicator data extraction*

An indicator-charting form was developed using *Google Forms* technology (**Appendix 5**). Team 1 charted independently indicators from papers selected for the health-indicator extraction phase in a pilot test. A randomised sample of approximately 15% of the papers chosen during the full-text reading stage was examined. Team 1 ensured the correct extraction of indicators from papers distributed to the Team 2. For this reason, five papers of those assigned to each collaborator were also reviewed by the researchers in Team 1 in a new pilot test. For the rest of the assigned papers, Team 2 extracted indicators while Team 1 checked that all the fields required for each indicator were correctly filled-in on the indicator-charting form. Some papers were discarded in this stage because they did not have enough information regarding indicators of the direct impact of COVID-19.

5. Data Items

Data were extracted at the study level (for the studies included in the full-text reading phase) and at indicator level (for a subset of approximately 15% of the papers chosen during the full-text reading phase). Variables collected at study level are shown in **Appendix 4**. Description and characteristics for each health indicator were extracted from a set of papers randomly selected and assigned to each reviewer and gathered in an online form (**Appendix 5**). Article characteristics were collected for each indicator and linked to study level information and debugged. If the same indicator was in two or more different papers, data was collected for each of them, considering the differences in the characteristics associated to each indicator (e.g. limitations to implement a specific indicator).

New variables categorising information from the original variables were created using Stata v.17 (10) (Supplementary material S1).

6. Synthesis of results

The indicators that measured similar clinical procedures, identical patients' sample, or similar outcomes were grouped together. Since there was some heterogeneity in indicators' titles referring to identical measures, a common indicator name was given by the Team 1 to each category of similar indicators (e.g.: "ventilation procedures"), using the original terminology from the studies as much as possible. Descriptive statistics were used to present characteristics of studies and indicators, providing absolute numbers and percentages. Tables show the frequencies of papers and indicators. A paper can have one or more indicators. A world map using the ggplot2 R-package (11) was developed, depicts the number of articles included in this rapid scoping review by country of affiliation of the first author. We grouped health indicators into morbidity, severity, mortality or a combination of the other three categories (composite). Flourish on-line tool (https://flourish.studio/) was used to present categories of indicators and their related subcategories.

7. Policy monitoring or decision tools of health promotion, prevention and care of COVID-19 patients

A survey was developed using *Google Forms* technology to gather indicators used in policy monitoring documents or decision tools and their characteristics (**Appendix 6**). Countries involved in the PHIRI project (in addition to the institutions collaborating to the subtask 5.1.2) were invited to identify experts who could complete the online form. Contributors were asked to identify whether the most frequently used health indicators to measure the direct impact of COVID-19, as identified in the scoping review, were also present in their national policy monitoring documents or decision tools.

Contributors were encouraged to search for national documents using keywords such as “action plan”, “traffic light”, “algorithm”, “score”, “degrees”, “strategy”, “monitoring”, “tool” or “evaluation” and to complete one survey per selected document. Contributors classified the aim of the documents as health promotion, prevention, or care; or a combination of these three categories. Data were extracted at the document level and debugged and structured using Stata v.17. Descriptive statistics were tabulated to show characteristics of documents and indicators, by absolute numbers and percentages.

D. Results

1. Selection of Sources of Evidence

After 262 duplicate records were removed, a total of 3891 citations were identified from searches into the three electronic databases: PubMed, Embase and WHO COVID-19 database. Based on the title and abstract, 3171 records were excluded, whereas 720 records were included for full-text reading. Of these, 275 were excluded during the full-text reading phase. The remaining 445 articles matched the inclusion criteria for retrieving information regarding health indicators of direct impact. A total of 67 (15%) of them were randomly selected to extract health-indicators data (**Figure 2**).

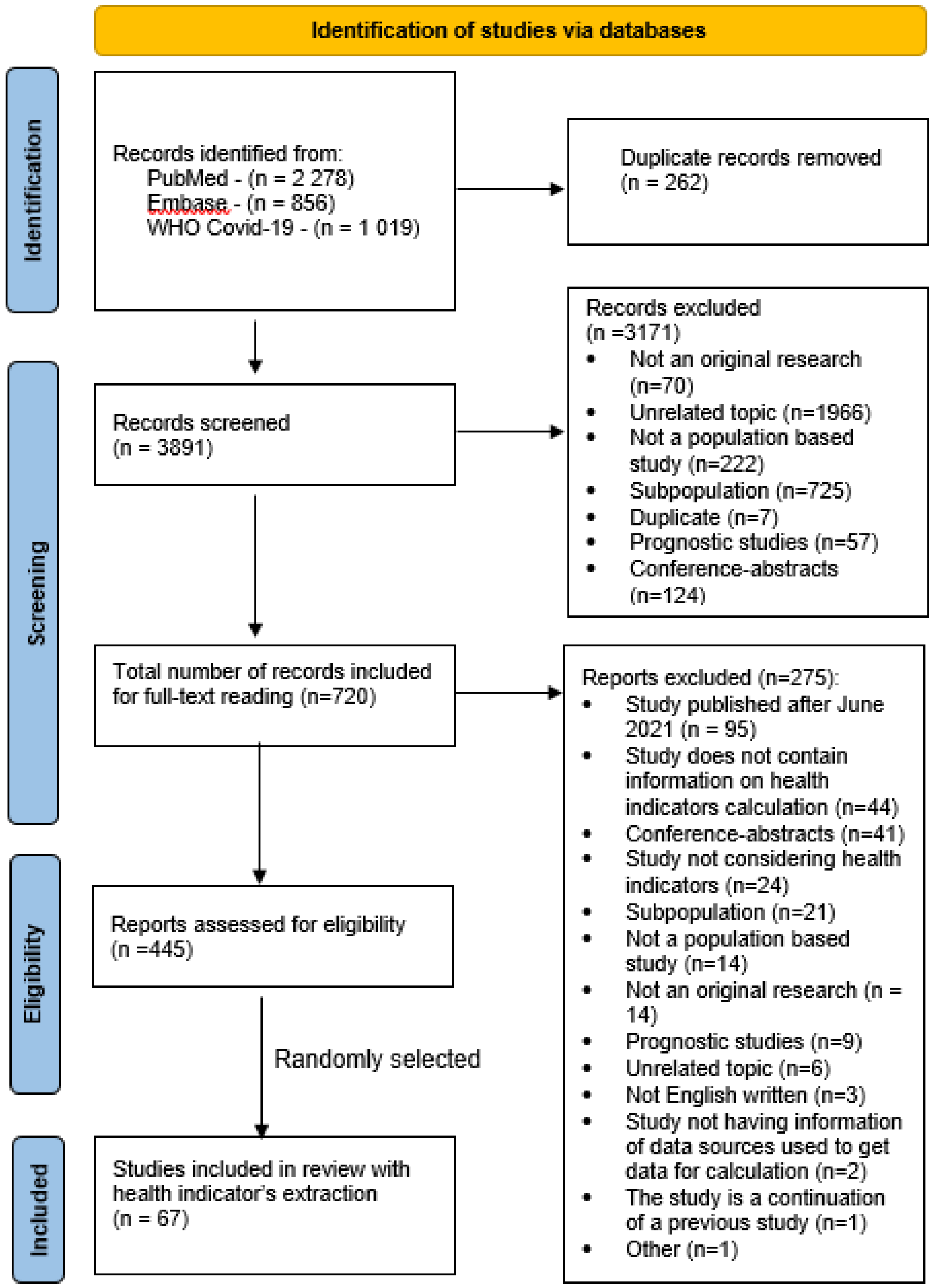

Figure 2. PRISMA 2020 flow diagram showing the selection process for the rapid scoping review of direct impact indicators of COVID-19

2. General characteristics of the included articles/studies

Sixty articles (89.5%) provided information on one country (**Figure 3**) and seven articles (10.5%) involved multiple countries. According to the affiliation of the first author, most of the studies were conducted by researchers based in the USA (**Table 1**). Consequently, most articles reported on the USA or some of its states or cities (15; 22.4%), followed by papers reporting on several countries or worldwide (6; 9.0%) and India (5; 7.5%) (**Table 2**). According to WHO region classification, most studies referred to the Americas and the European region (19; 8.4% and 18; 26.9%, respectively). Most of the studies used a cohort design (33 studies; 49.2%), followed by cross-sectional and ecological design (both 17; 25.4%) (**Table 3**). Study periods mainly finished between May and June 2020 (14; 21% for both months). The 57 papers reporting a study period presented a median duration of 4 months (interquartile range: 2 and 5 months). Most of the studies samples were drawn from the general population (37; 55.2%), followed by hospitalised patients (14; 20.9%). Regarding the diagnosis of SARS-CoV-2, 52 papers (77.6%) stated confirmation by a Polymerase Chain Reaction (PCR) test, whereas 15 papers (22.4%) did not report the type of confirmation or only some patients were confirmed by PCR. All values collected from each article are shown in columns for every variable in an Excel file (Supplementary Material S1)

Table 1. First author's country of affiliation of studies using indicators of direct impact of COVID-19, January 2020-June 2021

First author's country of affiliation	Number of articles/studies (n=67)	%	Number of indicators (n=233)	%
United States of America	18	26.9	70	30.0
United Kingdom	6	9.0	25	10.7
India	5	7.5	14	6.0
South Korea	4	6.0	26	11.2
China	3	4.5	8	3.4
Iran	3	4.5	12	5.2
Italy	3	4.5	11	4.7
Brazil	2	3.0	4	1.7
Denmark	2	3.0	10	4.3
France	2	3.0	3	1.3
Indonesia	2	3.0	4	1.7
Norway	2	3.0	8	3.4
Spain	2	3.0	10	4.3
Andorra	1	1.5	1	0.4
Canada	1	1.5	3	1.3
Colombia	1	1.5	1	0.4
Iraq	1	1.5	2	0.9
Mexico	1	1.5	1	0.4
Oman	1	1.5	1	0.4
Peru	1	1.5	1	0.4
Pakistan	1	1.5	1	0.4
Philippines	1	1.5	10	4.3
Poland	1	1.5	2	0.9
Japan	1	1.5	3	1.3
Taiwan	1	1.5	1	0.4
Turkey	1	1.5	1	0.4

Table 2. Countries and WHO-regions of studies using indicators of direct impact of COVID-19, January 2020-June 2021

Characteristic	Number of articles/studies (n=67)	%	Number of indicators (n=233)	%
Study country				
USA	15	22.4	60	25.8
India	5	7.5	14	6.0
United Kingdom	4	6.0	20	8.6
China	4	6.0	13	5.6
South Korea	4	6.0	26	11.2
Italy	3	4.5	11	4.7
Iran	3	4.5	12	5.2
Denmark	2	3.0	10	4.3
France	2	3.0	3	1.3
Indonesia	2	3.0	4	1.7
Norway	2	3.0	8	3.4
Spain	2	3.0	10	4.3
Andorra	1	1.5	1	0.4
Brazil	1	1.5	3	1.3
Colombia	1	1.5	1	0.4
Iraq	1	1.5	2	0.9
Japan	1	1.5	3	1.3
Mexico	1	1.5	1	0.4
Oman	1	1.5	1	0.4
Pakistan	1	1.5	1	0.4
Peru	1	1.5	1	0.4
Philippines	1	1.5	10	4.3
Poland	1	1.5	2	0.9
Turkey	1	1.5	2	0.9
Worldwide	6	9.0	10	4.3
Africa	1	1.5	4	1.7
Study WHO Region				
Americas	19	28.4	66	28.3
European region	18	26.9	67	28.8
Western Pacific Region	10	14.9	52	22.3
South-East Asia Region	7	10.5	18	7.7
Eastern Mediterranean Region	6	9.0	16	6.9
Worldwide	6	9.0	10	4.3
African region	1	1.5	4	1.7

Table 3. Characteristics of studies using indicators of direct impact of COVID-19, January 2020-June 2021

Characteristic	Number of articles/studies (n=67)	%	Number of indicators (n=233)	%
Study end (month)				
Jan-20	1	1.5	1	0.4
Feb-20	2	3.0	6	2.6
Mar-20	4	6.0	16	6.9
Apr-20	10	14.9	47	20.2
May-20	14	20.9	47	20.2
Jun-20	14	20.9	45	19.3
Jul-20	6	9.0	28	12.0
Ago-20	3	4.5	13	5.6
Sep-20	4	6.0	6	2.6
Nov-20	2	3.0	4	1.7
Dic-20	5	7.5	14	6.0
Jan-21	1	1.5	4	1.7
Feb-21	1	1.5	2	0.9
Study design				
Cohort study	33	49.2	164	70.4
Cross-sectional study	17	25.4	32	13.7
Ecological study	17	25.4	37	15.9
Study sample				
General population	38	56.7	97	41.6
Hospitalised patients	14	20.9	78	33.5
Inpatients/Outpatients	10	14.9	38	16.3
Patients in/requiring ICU	2	3.0	14	6.0
People living in LTCF	2	3.0	5	2.2
Close contacts	1	1.5	1	0.4
SARS-CoV-2 infection diagnosis				
Confirmed	52	77.6	190	81.6
Not confirmed, unclear or mixed	15	22.4	43	18.5

ICU: intensive care unit; LTCF: long-term care facility

Figure 3. Country distribution (first authorship) of included articles (excluding articles reporting on multiple countries)

3. Direct Impact of COVID-19 on population's morbidity, severity and mortality

We identified **233 indicators of the direct impact of COVID-19**. The number of indicators available per study varied from one to 13. The median number of indicators was 3 per paper (interquartile range: 2 to 4). Most of the indicators were classified as severity indicators (105, 45.1%; from 27 articles) (**Table 4**), mainly implemented in hospitals (95 out of 105, 85.7%). Sixty-eight mortality indicators were identified (29.2%); half of them were calculated using general population samples (35 out of 68, 51.5%). Morbidity indicators (52, 22.3%) were principally drawn from the general population (41 out of 52, 78.9%). Most of the direct impact indicators were expressed as a proportion (129, 55.4%), followed by those estimated as a rate (66, 28.3%) (**Table 5**). The most often numerators used among the selected indicators (**Table 6**) were confirmed COVID-19 deaths (46, 19.7%), ventilation therapies (39, 16.7%) and confirmed cases (38, 16.3%)

The most common data sources used to calculate the indicators were COVID-19 epidemiological surveys or COVID-19 registries (89, 38.2%) (**Table 7**). However, secondary data sources were used more often (national registries, insurance claims, hospital or primary care records, or civil registries, i.e.: 109, 46.8%).

The indicators extracted from the scientific literature were analysed according to the group of interest monitored, such as age (104; 44.6%), sex (96; 41.2%) and other variables listed in **Table 8**. Strengths were identified for indicator´s calculation (**Table 9**). Data collection (97; 41.6%), large sample (83; 35.6%) and representativeness (73; 31.3%) were the most reported strengths. However, indicators' strengths were not mentioned for 74 indicators (31.8%) from 27 articles (40.3%). Limitations reported for indicators' calculation were: missing data (68; 29.2%), lack of representativeness (63; 27.0%) and SARS-CoV-2 infection diagnosis not stated (43; 18.5%). There were no limitations identified for 32 indicators (13.7%), drawn from 13 papers (19.4%) (**Table 9**).

Table 4. Type of indicators related to direct impact of COVID-19, January 2020-June 2021

Characteristic	Number of articles/studies (n)	% [a]	Number of indicators (n)	%
Category of indicator				
Morbidity	33	49.3	52	22.3
Severity	27	40.3	105	45.1
Mortality	51	76.1	68	29.2
Composite	5	7.5	8	3.4
Type of morbidity indicator				
New cases in the population	15	45.5	18	34.6
Positivity rate	12	36.4	14	26.9
New and pre-existing cases divided by population	7	21.2	7	13.5
Percentage symptomatic/asymptomatic	3	9.1	4	7.7
Secondary attack rate	3	9.1	3	5.8
Incubation	2	6.1	2	3.9
Growth rate	1	3.0	1	1.9
Infection case ratio	1	3.0	1	1.9
Reproductive number	1	3.0	1	1.9
Space-time cluster	1	3.0	1	1.9
Type of severity indicator				
Ventilation procedures	16	59.3	37	35.2
Mechanical ventilation	14	37.8 [b]	22	59.5
Supplemental oxygen	9	24.3 [b]	14	37.8
ECMO	6	16.2 [b]	7	18.9
Type of ventilation procedure not reported	2	5.4 [b]	3	8.1
Clinical outcomes/ Complications	10	37.0	15	14.3
ARDS/acute respiratory failure	5	33.3 [c]	5	33.3
Acute kidney injury	3	20.0 [c]	3	20.0
Pneumonia	3	20.0 [c]	4	26.7
Dyspnea	2	13.3 [c]	2	13.3
Multiorgan failure	2	13.3 [c]	2	13.3
Septic shock	2	13.3 [c]	2	13.3
ICU	15	55.6	17	16.2
LOS at hospital	11	40.7	15	14.3
Hospitalisation	10	37.0	11	10.5
Treatments	4	14.8	4	3.8
Length ventilation	1	3.7	1	1.0
Other severity classifications	5	18.5	5	4.8
Type of mortality indicator				
Fatality rate	36	70.6	40	58.8
Mortality rate	19	37.3	24	35.3
Time to death	2	3.9	2	2.9
Mean daily increase in deaths until the peak in mortality	1	2.0	1	1.5
YLL	1	2.0	1	1.5
Type of composite indicator				
Mortality, severity	3	60.0	4	50.0
Morbidity, mortality, severity	1	20.0	3	37.5
Morbidity, severity	1	20.0	1	12.5

ARDS: acute respiratory distress syndrome; ECMO: extracorporeal membrane oxygenation; ICU: Intensive Care Unit; LOS: length of stay; YLL: years of life lost. [a] Percentage of papers having the indicators by category, e.g.: 33 papers had indicators of morbidity among a total of 67 papers, that is equals to 49.3% of the papers (total of percentages is higher than 100%). [b] Percentages calculated over the 16 papers reporting indicators of ventilation procedures. [c] Percentages calculated over the 10 papers reporting indicators of "clinical outcomes or complications", non-excluding categories (total of percentages for "clinical outcomes or complications" is higher than 100%)

Table 5. Calculation of indicators related to direct impact of COVID-19, January 2020-June 2021

Characteristic	Number of articles/studies (n)	% [a]	Number of indicators (n)	%
How the indicator is mathematically expressed				
Proportion	45	67.2	129	55.4
Rate	31	46.3	66	28.3
Count	16	23.9	29	12.5
DALYs	1	1.5	2	0.9
Yes/no	1	1.5	2	0.9
mL per kg	1	1.5	1	0.4
Odds	1	1.5	1	0.4
Space-time cluster	1	1.5	1	0.4
YLD	1	1.5	1	0.4
YLL	1	1.5	1	0.4
How coefficient was calculated				
100 (i.e. %)	53	79.1	153	65.7
100,000	10	14.9	20	8.6
1000 (i.e. ‰)	5	7.5	11	4.7
1,000,000	4	6.0	5	2.2
10,000	4	6.0	4	1.7
None, N/A	20	29.9	40	17.2

DALYs: disability-adjusted life years; YLD: years lost due to disability; YLL: years of life lost; N/A: not applicable.

Table 6. Type of numerator and denominator of indicators related to direct impact of COVID-19, January 2020-June 2021

Characteristic	Number of articles/studies (n)	% [a]	Number of indicators (n)	%
Numerator				
Confirmed COVID-19 deaths	29	43.3	46	19.7
Ventilation therapies (or requesting)	16	23.9	39	16.7
Confirmed cases	27	40.3	38	16.3
Hospitalised or severe	20	29.9	29	12.5
COVID-19 deaths (whether confirmed or not)	20	29.9	25	10.7
LOS	10	14.9	14	6.0
Cumulative cases	10	14.9	10	4.3
Symptomatic cases	4	6.0	5	2.2
Renal therapies	4	6.0	4	1.7
Time to outcome	3	4.5	4	1.7
Contact with cases	3	4.5	3	1.3
Seropositives	3	4.5	3	1.3
All-cause deaths	2	3.0	2	0.9
DALYs	1	1.5	2	0.9
Incubation period	2	3.0	2	0.9
Active cases	1	1.5	1	0.4
Asymptomatic cases	1	1.5	1	0.4
Daily increase in deaths	1	1.5	1	0.4
Death or ICU	1	1.5	1	0.4
Expected COVID-19 infections	1	1.5	1	0.4
YLL	1	1.5	1	0.4
YLDs	1	1.5	1	0.4
Denominator				
Symptomatic cases	20	29.9	51	21.89
Positive tests	27	40.3	48	20.6
Population	30	44.8	47	20.17
Tested PCR/confirmed cases	9	13.4	16	6.87
Total tests	7	10.4	10	4.29
Patients with/without COVID19	2	3.0	8	3.43
COVID-19 patients and deaths	1	1.5	6	2.58
Exposed people	4	6.0	4	1.72
Possible cases	2	3.0	3	1.29
IgG ab tested	2	3.0	2	0.86
Days	2	3.0	2	0.86
FiO_2	1	1.5	2	0.86
YLL	1	1.5	1	0.43
N/A	18	26.9	33	14.16

DALYs: disability-adjusted life years; Dx: diagnosis; FiO_2: fraction of inspired oxygen; ICU: Intensive Care Unit; IgG ab: immunoglobulin G antibody; LOS: length of stay; N/A: not applicable; PCR: polymerase chain reaction assay; YLD: years lost due to disability; YLL: years of life lost. [a] Percentage of papers having the indicators by category, e.g.: 33 papers had indicators of morbidity among a total of 67 papers, that is equals to 49.3% of the papers (total of percentages is higher than 100%).

Table 7. Sources providing data on indicators of direct impact of COVID-19, January 2020-June 2021

Characteristic	Number of articles/studies (n)	% [a]	Number of indicators (n)	%
Numerator data source				
COVID-19 epidemiological survey/registry	29	43.3	89	38.2
International/national/regional registry	17	25.4	51	21.9
In-house databases and serological survey	8	11.9	35	15.0
Insurance claims	3	4.5	20	8.6
Hospital admission records	7	10.4	18	7.7
Civil registry and national patient registry	2	3.0	10	4.3
Hospital admission records and death certificates	1	1.5	3	1.3
Inpatient and outpatient visits	1	1.5	3	1.3
Primary care visits	1	1.5	3	1.3
Death registry	1	1.5	1	0.4
Denominator data source				
COVID-19 epidemiological survey/registry	23	34.3	60	25.8
International/national/regional registry	20	29.9	45	19.3
Census	17	25.4	29	12.5
Hospital admission records	14	20.9	25	10.7
In-house databases and serological survey	7	10.4	24	10.3
Insurance claims	3	4.5	11	4.7
Primary care visits	1	1.5	3	1.3
Inpatient and outpatient visits	1	1.5	2	0.9
N/A	19	28.4	34	14.6
Denominator setting				
Hospital	25	37.3	94	40.3
General population	39	58.2	78	33.5
ICUs	6	9.0	13	5.6
Long-term care facilities	9	13.4	13	5.6
Patients + Outpatients	1	1.5	2	0.9
N/A	18	26.9	33	14.2

ICU: intensive care unit; N/A: not applicable; PCR: polymerase chain reaction assay. [a] Percentage of papers having the indicators by category, e.g.: 33 papers had indicators of morbidity among a total of 67 papers, that is equals to 49.3% of the papers (total of percentages is higher than 100%).

Table 8. Contextual variables of indicators related to direct impact of COVID-19, January 2020-June 2021

Characteristic	Number of articles/studies (n)	% [a]	Number of indicators (n)	%
Area of reference [b]				
Global	2	3.0	5	2.2
National/country	36	53.7	121	51.9
Region/county/department	23	34.3	67	28.8
City/municipality	14	20.9	44	18.9
District	1	1.5	1	0.4
Hospital	2	3.0	12	5.2
Long-term care facilities	2	3.0	11	4.7
Reference period				
Cumulative for the period	49	73.1	168	72.1
Year	2	3.0	2	0.9
Month	14	20.9	45	19.3
Week	4	6.0	5	2.2
Day	8	11.9	11	4.7
Hour [b]	1	1.5	2	0.9
Stratification by: [c]				
Age	39	58.2	104	44.6
Sex	35	52.2	96	41.2
Comorbidities	23	34.3	57	24.5
Geographic area	25	37.3	52	22.3
Ethnicity	14	20.9	46	19.7
SES	13	19.4	31	13.3
BMI	7	10.4	25	10.7
Severity	5	7.5	22	9.4
Smoking	8	11.9	20	8.6
Symptoms	6	9.0	12	5.2
Travelling abroad	4	6.0	10	4.3
Ventilation treatment	3	4.5	10	4.3
Education	3	4.5	9	3.9
Pharmacological treatment	4	6.0	8	3.4
Risk categories	2	3.0	7	3.0
Long-term care facility	3	4.5	7	3.0
ICU admission	3	4.5	6	2.6
Deprivation index	3	4.5	5	2.2
Anti-SARS-CoV-2 IgG level	1	1.5	3	1.3
DCI	1	1.5	3	1.3
Housing (size, ownership)	3	4.5	3	1.3
Occupation	3	4.5	3	1.3
LOS	2	3.0	2	0.9
Renal replacement (yes/no)	1	1.5	2	0.9
Politics	1	1.5	2	0.9
Biomarkers	1	1.5	2	0.9
Hospital resources	1	1.5	1	0.4
Nationality	1	1.5	1	0.4
Type of contacts	1	1.5	1	0.4
Vaccination status	1	1.5	1	0.4
No stratification	1	1.5	1	0.4

BMI: body mass index; DCI: distress communities index; ICU: Intensive Care Unit; IgG: immunoglobulin G; LOS: length of stay; SES: socioeconomic status. [a] Percentage of papers having the indicators by category, e.g.: 33 papers had indicators of morbidity among a total of 67 papers, that is equals to 49.3% of the papers (total of percentages is higher than 100%). [b] Richardson et al. estimated mortality within 48- and 72-hours. [c]Non-excluding categories (total of percentages is higher than 100%).

Table 9. Strengths and limitations for indicators related to direct impact of COVID-19, January 2020-June 2021

Characteristic	Number of articles/studies (n)	% [a]	Number of indicators (n)	%
Strengths [b]				
Data collection	22	32.8	97	41.6
Large sample	24	35.8	83	35.6
Representativeness	20	29.9	73	31.3
Detection of asymptomatic patients	8	11.9	16	6.9
Calculation of disabilities (formulae endorsed by the WHO)	1	1.5	4	1.7
Random sample	1	1.5	3	1.3
Reduce heterogeneity	1	1.5	2	0.9
Comparable	1	1.5	1	0.4
Early signals ICU	1	1.5	1	0.4
Other strengths	6	9.0	7	3.0
Not mentioned and not reported by collaborators	27	40.3	74	31.8
Limitations [b]				
Missing data	14	20.9	68	29.2
Lack of representativeness	17	25.4	63	27.0
SARS-CoV-2 infection diagnosis not clear	15	22.4	43	18.5
Enrolment (participation) bias	8	11.9	41	17.6
Data collection bias	15	22.4	31	13.3
Lack of more granular data	13	19.4	30	12.9
Small sample	7	10.4	30	12.9
Convenience sample	4	6.0	19	8.2
Lack of external validation	2	3.0	10	4.3
Selection bias	4	6.0	8	3.4
Cannot establish a causal relationship	2	3.0	4	1.7
Ecological fallacy	1	1.5	3	1.3
Information bias	1	1.5	3	1.3
Testing variability	1	1.5	3	1.3
Differences in referral patterns	1	1.5	1	0.4
False-positive cases	1	1.5	1	0.4
Lack internal valid COVID-19 Diagnosis	1	1.5	1	0.4
Other limitations	15	22.4	29	12.5
Not mentioned	13	19.4	32	13.7

ICU: Intensive Care Unit; WHO: World Health Organisation. [a] Percentage of papers having the indicators by category, e.g.: 33 papers had indicators of morbidity among a total of 67 papers, that is equals to 49.3% of the papers (total of percentages is higher than 100%). [b] Non-excluding categories (total of percentages is higher than 100%).

a) Morbidity indicators

A total of **52 indicators** (22.3%) regarding morbidity were identified in **33 articles** (49.3%) (**Table 2**) (1,12–40). These indicators were grouped into **10 separate categories** (**Figure 4**).

The most common category of morbidity indicators was “new cases in the population” (18 indicators; 34.6%), including “incidence rate” (19); “number of cumulative confirmed cases per 100,000 population” (25); “SARS-CoV-2 confirmed infections” (41); “COVID-19 incidence rates/100,000” (30) and “weekly COVID-19 confirmed cases per 1000 nursing home residents” (23) among other definitions for new cases. It was followed by “positivity rate” (14 indicators; 26.9%). The categories included in blue circles have the same values [P:1 (3.0%) and I:1 (1.9%)].

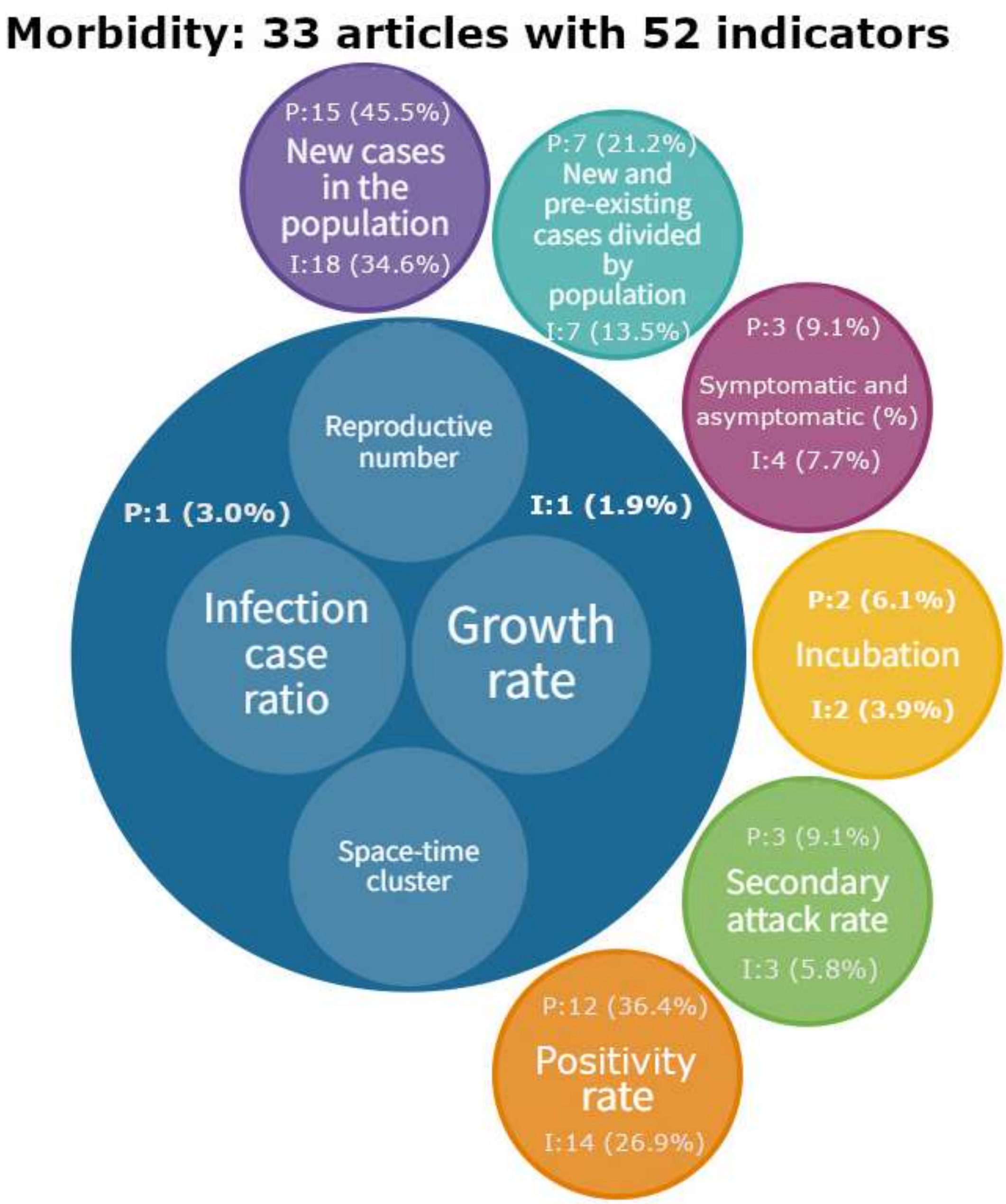

Figure 4. Main categories for morbidity indicators. Some indicators, belonging to a single paper, were grouped within a category together. Some indicators coming from a single paper were distributed in more than one category. I: number of indicators; P: number of papers

b) Severity indicators

A total of **105 indicators** (45.1%) regarding severity were identified in **27 articles** (40.3%) (**Table 2**) (13,20,23,37,41–62). These indicators were grouped into **8 separate categories** (**Figure 5**).

The most common category of severity indicators was "ventilation procedures" (37 indicators; 35.2%) (13,23,44–46,50,51,54,55,57–60,62,63). Of these indicators, 22 (59.5%) reported "mechanical ventilation" (invasive and non-invasive), 14 (37.8%) reported "supplemental oxygen", 7 (18.9%) reported "extracorporeal membrane oxygenation" (ECMO) and 3 (8.1%) did not report the type of ventilation.

The most common category was followed by "intensive care unit (ICU) admission" (17 indicators; 16.2%), "length of stay at hospital" (15 indicators; 14.3%) and "clinical outcomes/complications" (15 indicators; 14.3%). The categories included in maroon circles have the same values [P:2 (13.3%) and I:2 (13.3%)] (**Figure 5**).

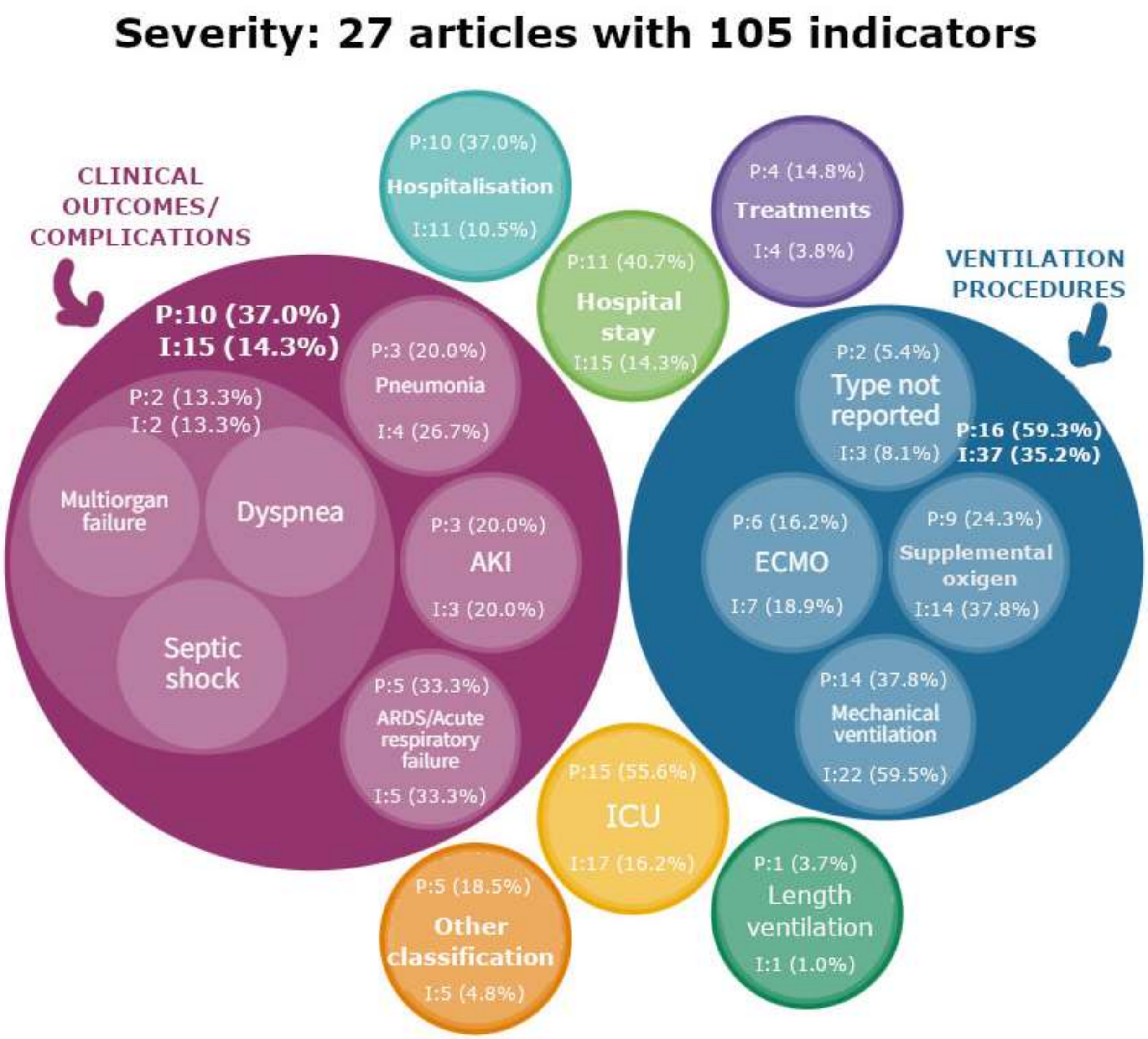

Figure 5. Main categories for severity indicators. Some indicators, belonging to a single paper, were grouped within a category together. Some indicators coming from a single paper were distributed in more than one category. AKI: acute kidney injury; ARDS: acute respiratory distress syndrome; ECMO: extracorporeal membrane oxygenation; I: number of indicators; P: number of papers

c) Mortality indicators

A total of **68 indicators** (29.2%) regarding mortality were identified from **51 articles** (76.1%) (**Table 2**) (1,14,16,17,21,23,25,28,30–32,34,37–39,41–57,59–74). These indicators were grouped into **5 separate categories** (**Figure 6**).

The most common categories regarding mortality indicators were “fatality rate” (40 indicators; 58.8%) and “mortality rate” (24 indicators; 35.3%).

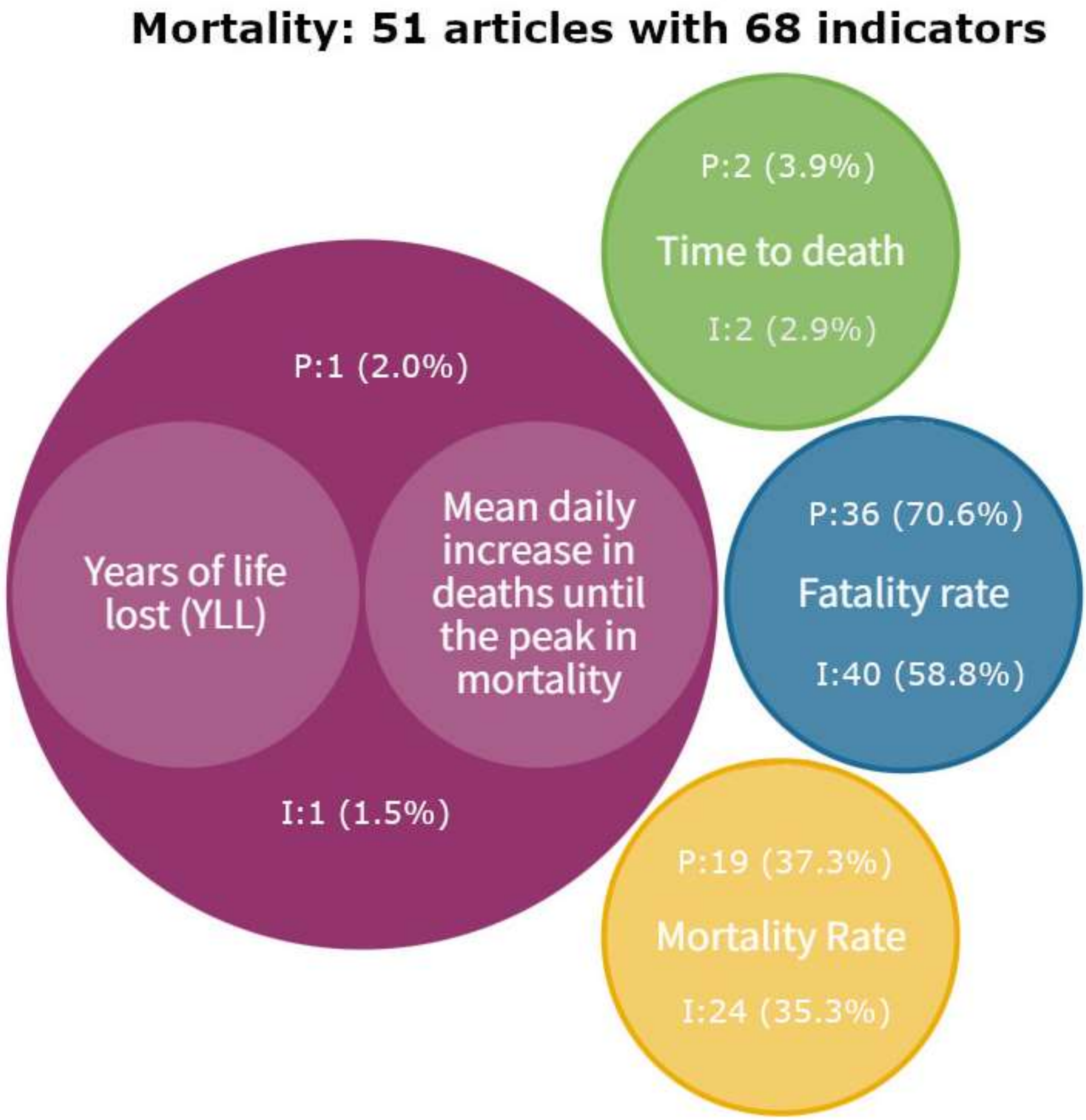

Figure 6. Main categories for mortality indicators. Some indicators-belonging to a single paper-, were grouped within a category together. Some indicators from a single paper were distributed in more than one category. I: number of indicators; P: number of papers

d) *Composite indicators*

A total of **8** (3.4%) **indicators** combining information from morbidity, severity or mortality were identified from **5** (7.5%) **articles** (**Table 2**) (24,45,67,71,75). These indicators were grouped into **3 separate categories**: 4 indicators (50.0%) were classified in the *mortality and severity* category (e.g. death/ICU admission), 3 indicators (37.5%) in a category combining morbidity, mortality and severity (e.g. Years Lost due to Disability (YLD) for incident cases of the disease or injury) and 1 indicator (12.5%) referred to a category combining morbidity and severity (i.e. Emergency Medical Service calls, percentage of positive RT-PCR tests, ambulances used, Emergency Department visits and GP visits).

4. Indicators used in policy monitoring or decision tools of health promotion, prevention and care of COVID-19 patients: results

The survey on policy monitoring or decision tools for health promotion, prevention and care of COVID-19 patients was completed by 22 contributors: Austria, Belgium, Bosnia Herzegovina, Croatia, Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Luxembourg, Norway, Poland, Portugal, Romania, Slovenia, Spain, Sweden and the United Kingdom. Contributors from Austria, Belgium, Estonia, Italy and Slovenia extracted information from more than one questionnaire based on different policy or decision tool documents. A total of 31 questionnaires were completed. Most of the selected documents were focused on “prevention and care of COVID-19 patients” (n=12, 38.7%), followed by those focusing on “promotion, prevention and care of COVID-19 patients” (n=8, 25.8%) or just “prevention” (n=7, 22.6%) (**Table 10**). Five of the contributions were dashboards (16.1%) whereas 7 were weekly reports (22.6%).

Table 10. Aim of the documents including indicators related to direct impact of COVID-19 retrieved from policy monitoring and decision tool documents

Aim of the document	Number of documents (n)	%
Promotion	1	3.2
Prevention	7	22.6
Care of COVID-19 patients	1	3.2
Promotion and prevention	2	6.5
Prevention and care	12	38.7
Promotion, prevention and care	8	25.8

The majority of the identified indicators were morbidity indicators (29, 93.5%, non-excluding categories) followed by mortality indicators (26, 83.9%) (**Table 11**). The most used formulae were rates and counts (24, 77.4%, respectively) (**Table 12**). Almost all the documents and tools reported were primary data sources (29, 93.5%). Indicators were mainly expressed as percentages (28, 90.3%) and rates per 100,000 habitants (13, 41.9%). The most referenced area and period were country and week (29, 93.5% and 24, 77.4%, respectively). The indicators were mostly stratified by age (28, 90.3%), sex and geographic area (25, 80.6%, both). The most reported strength was data collection (22, 71.0%). The contributors to this survey found few documents reporting limitations of the indicators (4, 12.9%). Limitations referred to missing data and diagnosis of the SARS-CoV-2 were not well defined (6, 19.4%, both limitations) (**Table 12**).

Table 11. Type of indicators related to direct impact of COVID-19 retrieved from policy monitoring and decision tool documents

Type of indicators	Number of documents (n)	%
Type of indicators		
Morbidity	29	93.5
Severity	20	64.5
Mortality	26	83.9
Composite	10	32.3
Morbidity indicators[a]		
New cases	25	86.2
Positivity rate	22	75.9
New and previous cases	17	58.6
Severity indicators[b]		
ICU admission	18	90.0
Length of stay	6	30.0
Ventilation procedures	6	30.0
Clinical outcomes/complications	2	10.0
Hospitalisation	2	10.0
Mortality indicators[c]		
Mortality rate	25	96.2
Fatality rate	13	50.0
Items making composite indicators[d]		
ICU admission	2	20.0
New cases	1	10.0
Positivity rate	1	10.0
New and previous cases	1	10.0
Ventilation procedures	1	10.0
Mortality rate	1	10.0

[a] Divided by the 29 documents with morbidity indicators. [b] Divided by the 20 documents with severity indicators. [c] Divided by 26 documents with mortality indicators. [d] To estimate percentage: Numerator includes number of documents where only composite indicator was reported, denominator has the 10 documents with composite indicators.

Table 12. Characteristics of indicators related to direct impact of COVID-19 retrieved from policy monitoring and decision tool documents.

Type of indicators	Number of documents (n)	%
How the indicators are mathematically expressed		
Proportion	20	64.5
Rate	24	77.4
Count	24	77.4
Data sources		
Primary data source	29	93.5
Secondary data source	21	67.7
How coefficients are expressed		
100 (i.e. %)	28	90.3
1000 (i.e ‰)	1	3.2
10,000	1	3.2
100,000	13	41.9
1,000,000	2	6.5
N/A	3	9.7
Area of reference	13	50.0
National/Country	29	93.5
Region/county/department	23	74.2
City/ municipality	8	25.8
Reference period	2	18.2
Defined period (e.g. March 2020 to June 2020)	18	58.1
Month	5	16.1
Week	24	77.4
Day	11	35.5
Stratification by		
Age	28	90.3
Sex	25	80.6
Geographic area (country, state, province, urban/rural...)	25	80.6
Comorbidities	6	19.4
Socio economic status	3	9.7
Ethnicity	0	0.0
Indicators' strengths		
Data collection	22	71.0
Large sample	19	61.3
Representativeness	18	58.1
Not described	4	12.9
Indicators' limitations		
Missing data	6	19.4
SARS-CoV-2 infection diagnosis not clear	6	19.4
Lack of representativeness	3	9.7
Enrolment (participation) bias	2	6.5
Not described	20	64.5

N/A: not applicable.

E. Discussion

The identification of methodological issues and indicators of direct impact was performed in two complementary phases: a rapid scoping review to collect information from the scientific literature and the data collection from documents on policy monitoring and decision tools.

More than 200 quantitative indicators were used in a sample of 67 studies. The 10 indicators of direct impact that were most frequently identified in the scoping review were searched in 31 policy monitoring documents and decision tools. COVID-19 impact was mainly measured by severity indicators, followed by mortality and morbidity indicators in the articles included in the scoping review. The policy documents and decision tools reported in the survey mainly assessed COVID-19 impact using morbidity indicators followed by mortality indicators. In addition, eight indicators used combinations of morbidity, severity or mortality measures to evaluate COVID-19 impact (24,67,71,75). The three most commonly used indicators found in the rapid scoping review were two indicators of mortality, "fatality rate" and "mortality rate"; and one indicator of severity, "proportion of patients requiring mechanical ventilation". From the survey, the three most used indicators were two morbidity ("new cases" and "positivity rate"); and one mortality ("mortality rate") indicators.

<u>Morbidity indicators</u>

Morbidity indicators aim to estimate the occurrence of diseases, lesions, and impairment in populations. Incidence is employed for acute illnesses of short duration which are curable or ends in death(76). The indicator "rate of new confirmed cases nationwide per 100,000 persons" was used to measure the incidence of notified COVID-19 cases in the community by the surveillance system of the ECDC (77). Both dashboards from the ECDC and the WHO estimated COVID-19 morbidity as incidence values per 100,000 population over the past 14 days (78,79). However, most studies identified in the scoping review estimated "cumulative incidence" for study periods ranging from 3 to 10 months when reporting new cases in the population, instead of 14-day periods (1,12,25,30,38,41,80). Most of the studies used convenience periods ("cumulative incidences" in a defined period) instead of reporting daily, weekly or monthly incidence (19,20,34). The authors obtained the indicators from the national systems of surveillance when communicated daily, weekly or monthly incidence. We found a different approach in a study analysing the whole of Africa, that calculated the "weekly growth rate" between a week compared to the week before (34). This way of reporting was also used by the ECDC to evaluate the change of the epidemic wave weekly (81). New cases were also utilised in policy monitoring documents and decision tools. Overall, these indicators were included in national weekly reports and dashboards.

Positivity rates allows for assessment of the intensity of the epidemic and level of transmission in the population over time (start, peak and end of a wave) (77). "Test positivity" was available for most of the EU/EEA Member States, and summarised by the ECDC (81). The test positivity, calculated by the ECDC, was obtained from the percentage of total tests. Most of test positivity indicators were obtained for a cumulative period longer than one month in scientific papers (1,16,36,82–84). Importantly, asymptomatic cases have been considered together with symptomatic as “seropositive” instead of “confirmed cases” (15,29). Another study differentiated between positive tests and active cases, generating an indicator of active rate as the percentage of active cases among positive tests (16). However, a definition of active case was not provided. The complementary information found in policy documents and tools matched the comprehensive use of positivity rate as indicators of direct impact caused by the COVID-19 disease.

The use of the “reproductive number” allows for a better understanding of the transmissibility of COVID-19 as well as effectiveness of interventions (40,77). “Reproductive numbers” or “secondary attack rates” (13,20,22) were calculated in some studies during the first waves of the pandemic informing important decisions such as movement restrictions.

Among the scientific papers included in rapid scoping review, the following morbidity indicators were not systematically used for the COVID-19 surveillance: “incubation period” (13,20), “infection case ratio” (29), “percentage of asymptomatic cases” among positive tests (20,36), and “space-time clusters” of COVID-19 (18). The space-time scan statistics are a family of techniques for disease surveillance and early detection which are not yet used for surveillance implemented by the ECDC, CDC or WHO. However, Spain implemented routinely surveillance of space-time clusters of COVID-19 (85,86).

Severity indicators

Considering that “admission to hospital” might be a proxy for disease severity, the rate of hospitalised COVID-19 cases is used as an indicator of the disease burden in the population (77). Severity was mainly surveyed by “rates of hospital admissions” and “ICU admissions” per 100,000 people weekly by the ECDC (81). Hospital admission rates were employed as a proxy for primary care quality, since high admission rates may indicate low care coordination or low care continuity. They may also point to structural constraints such as the insufficient number of general practitioners (87). The CDC used the indicator “new COVID-19 admissions per 100,000 population (7-day total)” and, when available, “percent of emergency department visits due to COVID-19” based on the syndromic surveillance (88).

The “proportion of COVID-19 cases requiring ICU” is another indicator of disease severity (77). Only one of the chosen studies reported rates of ICU admissions per 100,000 (41) in a similar way ECDC or CDC reports. The majority of scientific studies used proportions to calculate the ICU indicators among hospitalised patients instead of population rates (43,45,46,50,51,53,57,58,60,63). This is because scientific studies used ICU indicators which were mainly calculated from a sample of inpatients or visits to hospital instead of population covered by the hospitals.

The “proportion of hospitalised COVID-19 cases” out of all cases represented a proxy for severity when criteria for testing did not change. In other words, the proportion of hospitalised cases is an indicator of the disease burden and pressure on healthcare services (77). Scientific papers showed hospital indicators obtained from hospitalised or severe cases divided by positive tests (52,55,61), higher proportions would indicate a failure in the containment of the epidemic in the community.

The average “length of stay” in hospitals is often used as an indicator of care efficiency in health service delivery (87) and severity of illness (89). Length of stay at hospital due to COVID-19 has been used by surveillance systems as a health indicator by some countries such as Belgium (90). However, notification regarding dates of admission and discharge are collected but not reported to calculate length of stay (e.g. English and Spanish reports) (91,92)). The European Core Health Indicators (ECHI) includes “length of stay” among the relevant indicators for health services and health care to assess sustainable health care systems, health system performance, quality of care, efficiency of care and patient safety (93). “Length of stay at hospital” (44,46,48–50,54,57,60,63), and “length of stay at ICU” (53,54,59) are frequent used indicators of direct impact of COVID-19 assessing severity among the scientific papers that we have reviewed.

The “proportion of COVID-19 cases requiring respiratory support” is also an indicator of disease severity (77). Ventilation procedures were reported in 16 studies (13,44–46,51,54,55,59–63,94). Those studies also evaluated percentage of mechanical ventilation and duration of mechanical ventilation. In this line, the WHO recommended to use the proportion of mechanical ventilators being used by COVID-19 patients to monitor health care capacity and utilization to support decision-making policy measures against the COVID-19 pandemic (95). Policy documents and tools also use “ICU admission”, “length of stay”, “ventilation procedures” and “hospitalisation” as indicators of COVID-19 severity.

Mortality indicators

Mortality is a key indicator of severity and a measure of effectiveness of control measures for COVID-19 (77). “Case fatality rate” estimates the severity of a disease, but only if the estimation of cases is reliable (96). In the included articles “fatality rate” was calculated using symptomatic cases or positive tests (12,16,17,21,23,30,34,37,39,43–46,49,51–56,58–62,64,65,67,69,70,72,94,97). Therefore, cases with mild or no symptoms were not included in the calculation based on symptomatic cases and COVID-19 mortality was overestimated. Another indicator of mortality, “mortality rate”, is obtained using population denominators varying between 10,000 and 1,000,000 habitants (1,12,14,17,25,41,66,68,97). In line with these mortality indicators, the WHO Coronavirus (COVID-19) dashboard also calculated mortality rate per 100,000 population (98). Both mortality rate and fatality rate were indicators described by public health institutions and governments across Europe, as shown by the review of survey in policy monitoring documents and decision tools.

Technical and policy documents

Some of the identified indicators collected from scientific papers are also used in technical and policy documents of cross-national public health authorities (77). These documents listed indicators such as the reproductive number, the rate of new confirmed cases or the fatality rate, among others. A technical report included the answer from eight EU countries that participated in a dialogue with the ECDC discussing their approaches to transitioning into the post-acute phase of the pandemic as well as de-escalating measures (99). In this report, the surveillance team of Denmark reported that they were still using in April 2022 “weekly confirmed COVID-19 cases per 100,000”, “positivity rate” and “growth rate”, among others. By the same date, the Health Alert and Emergency Co-ordination Centre (CCAES) of the Spanish Ministry of Health informed in this report about plans to keep using the indicator measuring the positivity rate per 100,000.

Strengths and limitations of the indicators

The indicator strengths were mainly identified at study design, i.e. data collection, large sample and representativeness, while it deemed limitations such as missing data and lack of representativeness. The survey on policies and tools found similar indicator strengths. However, the agreement in indicator limitations was lower, probably due to the use of consolidated indicators implemented time ago in surveillance systems. Therefore, strengths and limitations are strongly dependent on the data sources. Most of the indicators retrieved from the scientific papers were obtained from secondary data sources (census, national registries, hospital admission records, etc.). One of the advantages of using secondary data is the higher temporal and spatial comparability of data and indicators as a consequence of the feasibility of implementing more standardised definitions. However, differences in case definition, target population, absence of relevant variables or distinct levels of stratification among settings and countries could limit comparability. Multiple factors hinder comparisons between countries about the identified indicators in the scientific literature: definition of COVID-19 cases, death registrations, guidelines for case detection, case reporting systems, testing strategies, and validity of the tests (sensitivity and specificity).

Strengths and limitations of the studies reviewing scientific literature and policy monitoring documents and decision tools

The main strength of this report is the combination of complementary results from scientific articles and documents describing or disseminating policy monitoring and decision tools. The scientific papers reviewed have allowed to retrieve a large number of indicators, covering, thus, all main categories of indicators and collecting, if not all, at least the vast majority of indicators assessing the direct impact of the COVID-19 crises. The most used indicators found in the scientific papers were also present in policy monitoring documents and decision tools implemented across Europe. Therefore, well established indicators used by surveillance systems have proven their utility in monitoring the pandemic as reflected by their inclusion in policy monitoring documents, decision tools and in scientific literature.

Another advantage of the study of scientific publications is related to the importance of variables used for stratification of the indicators. Most of them were stratified by age, gender, comorbidities, geographic area, ethnicity and socioeconomic status. Some of these stratification variables are recommended to evaluate health inequalities by the Cochrane network (PROGRESS; Place, Race, Occupation, Gender, Education, Socioeconomic Status and Social capital or resources) (76,100). Accordingly, policy monitoring documents and decision tools included also that age, sex and geographic should be widely adopted for stratification of the indicators. Vulnerable groups, such as children, pregnant women or homeless people were underrepresented in the scientific literature retrieved because those groups were not included for eligibility criteria.

The study reviewing scientific publications had some limitations. It excluded non-English records, non-original research, grey literature and country-specific reports. By excluding these documents, we could miss reports using health indicators from other data sources. Nevertheless, the survey conducted on national policy monitoring documents and decision tools has balanced the contribution of non-English records with documents, reports, web sites and dashboards written in French, Estonian, Croatian, Czech, Norwegian, German, and Portuguese, among other languages.

The heterogeneity of indicator's names and definitions hindered their categorization, consequently limiting data comparison. In addition, not all indicators extracted from scientific papers evaluating COVID-19 direct impact could be suitable to assess other emerging infectious diseases. For example, the requirement of mechanical ventilation was mainly relevant in the context of a respiratory infection such as COVID-19. Despite the large number of European researchers involved in the selection of sources of evidence, there were some difficulties harmonising raw data across several tasks, including time to collect, organise, debug and synthesise a relevant number of indicators and their characteristics. For this reason, we decided to select a random sample of papers (n=67) to carry out the rapid scoping review instead of extracting information from all studies included in the full text reading phase. The number of indicators for selection was limited by design for the survey deployed to European experts on policy monitoring documents and decision tools. This design allowed us to obtain results faster than conducting a new scoping review. Hence, some relevant indicators may not be reported in the survey even though they were in the document. Nevertheless, the most frequently reported indicators in the scientific literature were consistently identified in policy monitoring documents and decision tools.

Another limitation of the study is the variation in the epidemic status of each country (96). Inclusion criteria retrieved papers published from January 2020 to June 2021, involving different epidemic waves according by country, circulating variant and epidemiological situation (101).

F. Conclusions and implications for public health

In our reviews, we summarised health indicators used to measure the direct impact of the COVID-19 pandemic on population's morbidity, severity and mortality. Other reviews focused on the impact of COVID-19 in certain diseases (e.g. cardiac disease or cancer) throughout performance indicators (that measures changes across care pathways) (102,103). The review of scientific publications, policy monitoring documents and decision tools presents a comprehensive overview of the health indicators used during the first waves of the pandemic. The indicators collated here might be useful to assess the impact of future pandemics. Therefore, it is crucial to harmonise their calculation to allow for comparisons between settings, countries and different populations.

The results of this report highlight the importance of reviewing scientific papers because they are digging into more detailed issues of epidemics and different ways of estimating health indicators that can remain uncovered by regular surveillance, showing diverse approaches which could potentially assess the impact of an epidemic. In addition, reviewing policy documents which are modified to adapt to the exceptional times of health crises is relevant to show how selected indicators can vary from regular surveillance and policy decisions in emergency depend on timely data collection.

We have obtained a wide variability of indicators reporting morbidity, severity or mortality. This classification could guide readers of scientific papers about the type of indicator used and the interpretations associated of a specific type of indicator. In turn, the use of subcategories of morbidity, severity and mortality could allow a better identification of appropriate indicators depending on the type of study to be conducted. Our investigation has unveiled the need to agree on a list of indicators among researchers to be included in their studies allowing for comparison of results among studies and countries. Researchers contributing with publications that use harmonised indicators could speed up findings beyond individual investigations in order to generate aggregated and cross-national information for decision makers in future health crisis. Shortlists of indicators such as the European Core Health Indicators (ECHI) could be improved with new groups of indicators for future health crises. For example, a new chapter to the ECHI Data Tool could be added (https://webgate.ec.europa.eu/dyna/echi/) including the relevant indicators to face a new epidemic caused by a respiratory disease. Hence, the indicators and their classification obtained in this research from scientific publications and policy documents could be used for surveillance in forthcoming epidemics. Some of the indicators identified in our research are not currently implemented in surveillance systems. They will need assessment by experts to ensure the highest comparability and the best quality. Moreover, scientific journals and funding bodies could support the selection of indicators from an internationally agreed shortlist when a health crisis like COVID-

19 begins. This way, researchers would be able to compare the vast number of technical documents and scientific publications quantitatively and cross-nationally.

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I. Appendixes

1. Working group

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2. PubMed Search Strategy

Date of search: 29.10.2021

Search	***Most Recent Queries***	***results***	***comment***
#1	("COVID-19" OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines" OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy" OR "COVID-19 serotherapy"[Supplementary Concept] OR "COVID-19 Nucleic Acid Testing" OR "covid-19 nucleic acid testing"[MeSH Terms] OR "COVID-19 Serological Testing" OR "covid-19 serological testing"[MeSH Terms] OR "COVID-19 Testing" OR "covid-19 testing"[MeSH Terms] OR "SARS-CoV-2" OR "sars-cov-2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2" OR "NCOV" OR "2019 NCOV" OR (("coronavirus"[MeSH Terms] OR "coronavirus" OR "COV") AND 2019/11/01[PDAT] : 3000/12/31[PDAT])) *AND ((2020/01/01:2021/06/30[Date - Publication] AND "english"[Language]) NOT ("animals"[MeSH Terms] NOT "humans"[MeSH Terms]))*	*152,526* *29.10.2021*	*Disease definition* 1. COVID-19 filter obtained from the National Library of Medicine. Section article filters. Limit retrieval to citations about the 2019 novel coronavirus. Category General. Filter name “LitCGeneral” = LitCGeneral[Filter] https://pubmed.ncbi.nlm.nih.gov/help 2. *Filter modified for retrieving human studies: Instead of human filter: NOT ("animals"[MeSH Terms] NOT "humans"[MeSH Terms]). Following the advice of the librarian from the Medical Library of the University Hospital of Getafe, Madrid, Spain https://bibliogetafe.com/*
#2	Epidemiologic Studies[Mesh]	*2,805,991* *29.10.2021*	*Study definition – MeSH Terms* *MeSH Terms included in Epidemiologic Studies[Mesh]* 1. Cohort studies[MeSH Terms] includes “incidence” in its entry terms: • Incidence Studies • Incidence Study • Studies, Incidence

			• Study, Incidence 2. Cross-sectional studies[MeSH Terms] includes “prevalence” in its entry terms: • Prevalence Studies • Prevalence Study • Studies, Prevalence • Study, Prevalence 3. Epidemiologic Studies[MeSH Terms] • Case-Control Studies • Retrospective Studies • Cohort Studies • Follow-Up Studies • Longitudinal Studies + • Prospective Studies • Retrospective Studies • Controlled Before-After Studies • Cross-Sectional Studies • Historically Controlled Study • Interrupted Time Series Analysis • Seroepidemiologic Studies o HIV Seroprevalence
#3	(Epidemiological Studies[tiab] OR Epidemiological Study[tiab] OR Epidemiologic Study[tiab] OR "cross-sectional"[tiab] OR "cross sectional"[tiab] OR Disease Frequency Survey*[tiab] OR "case-control"[tiab] OR "case control"[tiab] OR Case-Comp*[tiab] OR Case Comp*[tiab] OR Case-Refer*[tiab] OR Case Refer*[tiab] OR Case-Base[tiab] OR Case Base[tiab] OR cohort[tiab] OR Concurrent Stud*[tiab] OR longitudinal[tiab] OR follow?up[tiab] OR "prospective study"[tiab] OR "prospective studies"[tiab] OR "prospective design"[tiab] OR	*2,703,792 29.10.2021*	Study definition – [terms title/abstract/keywords]

	"prospective designs"[tiab] OR "retrospective study"[tiab] OR "retrospective studies"[tiab] OR "retrospective design"[tiab] OR "retrospective designs"[tiab] OR "prospective observational study"[tiab] OR "prospective observational studies"[tiab] OR "retrospective observational study"[tiab] OR "retrospective observational studies"[tiab] OR seroepidemiolog*[tiab] OR sero-epidemiolog*[tiab] OR serogroup epidemiology[tiab] OR serologic epidemiology[tiab] OR serological epidemiology[tiab] OR serotype epidemiology[tiab] OR serotypic epidemiology[tiab] OR ecological study[tiab] OR "ecological studies"[tiab] OR "ecological design"[tiab] OR "ecological designs"[tiab] OR observational[tiab] OR "observational study"[tiab] OR "observational study"[pt] OR "observational studies"[tiab] OR "observational design"[tiab] OR "observational designs"[tiab])		
#4	(#2) OR (#3)	4,027,321 *29.10.2021*	*Study definition – [MeSH Terms] + [terms title/abstract/keywords]*
#5	"Morbidity"[Mesh]	606,487 29.10.2021	*MeSH Terms included in Morbidity"[Mesh]* 1. Morbidity includes: • Basic Reproduction Number[Mesh] • Incidence[Mesh] • Prevalence[Mesh]
#6	R0[tiab] OR Basic reproductive number[tiab] OR time-varying reproduction number[tiab] OR reproduction	1,827,897 29.10.2021	*Indicator: Morbidity [terms title/abstract/keywords]*

	number[tiab] OR prevalence*[tiab] OR incidence*[tiab] OR morbidit*[tiab] OR Attack Rate*[tiab] OR Secondary Attack[tiab] OR Person-time Rate*[tiab] OR Person time Rate*[tiab]		
#7	(#5) OR (#6)	2,004,075 29.10.2021	*Indicator: Morbidity [MeSH Terms] + [terms title/abstract/keywords]*
#8	"Mortality"[Mesh]	408,873 29.10.2021	*Indicator: Mortality [MeSH Terms]*
#9	mortalit*[tiab] OR case-fatality rate[tiab] OR case fatality rate[tiab] OR death rate*[tiab] OR crude death[tiab] OR excess deaths [tiab] OR excess all cause deaths [tiab] OR excess number of deaths [tiab] OR excess COVID-19-related deaths [tiab] OR infection fatality r*[tiab] OR number covid-19 deaths [tiab] OR confirmed covid-19 deaths [tiab] OR deaths hospitalization ratio[tiab] OR survival[tiab] OR death toll[tiab] OR fatal outcome[tiab]	1,785,354 29.10.2021	*Indicator: Mortality [terms title/abstract/keywords]*
#10	(#8) OR (#9)	1,936,352 29.10.2021	*Indicator: Mortality [MeSH Terms] + [terms title/abstract/keywords]*
#11	("Patient Admission"[Mesh] OR "Intensive Care Units"[Mesh] OR "Respiration, Artificial"[Mesh] OR "Inpatients"[Mesh] OR "Risk Adjustment"[Mesh] OR "Outcome Assessment, Health Care"[Mesh])	1,432,901 29.10.2021	*Indicator: Severity – [MeSH Terms]*
#12	acute respiratory infection[tiab] OR Patient Admi*[tiab] OR Voluntary Admission*[tiab] OR hospital Admi*[tiab] OR intensive care[tiab] OR Respiratory Care Unit*[tiab] OR Recovery room*[tiab] OR close attention unit[tiab] OR critical care unit[tiab] OR intensive therapy unit[tiab] OR intensive treatment unit[tiab] OR special care	2,782,928 29.10.2021	*Indicator: Severity [terms title/abstract/keywords]*

	unit[tiab] OR Respiration, Artificial[tiab] OR Artificial Respirat*[tiab] OR Ventilation, Mechanical[tiab] OR mechanical ventilation*[tiab] OR Interactive Ventilatory[tiab] OR Ventilatory Support[tiab] OR Ventilatory Assist[tiab] OR Assist Ventilation[tiab] OR Ventilation, Proportional Assist[tiab] OR invasive ventilation[tiab] OR controlled respiration[tiab] OR controlled ventilation[tiab] OR mechanical respiration[tiab] OR mechanical ventilation[tiab] OR Inpatient*[tiab] OR in-patient*[tiab] OR Hospitalised patient*[tiab] OR hospitalized patient*[tiab] OR in-hospital patient*[tiab] OR Risk Adjustment*[tiab] OR risk analysis[tiab] OR risk evaluation[tiab] OR safety assessment[tiab] OR Case-Mix Adjustment*[tiab] OR Case Mix Adjustment*[tiab] OR Outcomes Assessment*[tiab] OR Outcome Assessment*[tiab] OR Outcomes Research[tiab] OR Outcome Stud*[tiab] OR Outcome Measure*[tiab] OR severity[tiab] OR case-hospitalization ratio[tiab] OR proportion of hospitalization[tiab]		
#13	(#11) OR (#12)	3,695,874 29.10.2021	*Indicator: Severity [MeSH Terms] + [terms title/abstract/keywords]*
#14	"Population Health"[Mesh]	39,980 *29.10.2021*	*General population definition [MeSH Terms]*
#15	(Population Health[tiab] OR populational health[tiab] OR general population[tiab] OR population stud*[tiab] OR population cohort study[tiab] OR population-based[tiab] OR community-based[tiab]	3,052,622 *29.10.2021*	*General population definition [terms title/abstract/keywords]*

	OR community dwelling[tiab] OR Nationwide[tiab] OR national cohort[tiab] OR million people[tiab] OR "federal state*"[tiab] OR "state level"[tiab] OR *region**[tiab] OR countr*[tiab] OR county[tiab] OR counties[tiab] OR nation*[tiab])		
#16	(#14) OR (#15)	3,080,050 29.10.2021	*General population definition [MeSH Terms] + [terms title/abstract/keywords]*
#17	"Nursing Homes"[Mesh] OR Homes for the Aged [Mesh]	47,142 29.10.2021	*Nursing homes definition [MeSH Terms]*
#18	Nursing Home*[tiab] OR convalescence home*[tiab] OR convalescence hospital*[tiab] OR extended care facilit*[tiab] OR long term care facilit*[tiab] OR skilled nursing facilit*[tiab] OR Homes for the Aged[tiab] OR Geriatric facilit*[tiab] OR Old Age Home*[tiab] OR long-term care[tiab] OR aged care home*[tiab] OR aged care facilit*[tiab] OR continuing care retirement center*[tiab] OR geriatric homes*[tiab] OR home? for the elderly[tiab] OR homes for the aged[tiab] OR housing for the elderly[tiab] OR old people home*[tiab] OR retirement center*[tiab] OR retirement centre*[tiab] OR retirement home*[tiab] OR senior residence facility*[tiab]	57,616 29.10.2021	*Nursing homes definition [terms title/abstract/keywords]*
#19	(#17) OR (#18)	76,487 29.10.2021	*Nursing homes definition [MeSH Terms] + [terms title/abstract/keywords]*
#20	((clinical[Title/Abstract] AND trial[Title/Abstract]) OR clinical trials as topic[MeSH Terms] OR clinical trial[Publication Type] OR random*[Title/Abstract] OR random allocation[MeSH Terms] OR therapeutic use[MeSH Subheading])	*5,878,395 29.10.2021*	*RCT definition* 1. RCT filter obtained from the National Library of Medicine. Optimized for sensitive/broad; sensitive/specific 99%/70%. https://pubmed.ncbi.nlm.nih.gov/help/#publication-types. Search filters based on the work of Haynes RB et al. doi: 10.1136/bmj.38068.557998

#21	("case report*"[tiab] OR ("case reports"[Publication Type] OR "case reports"[tiab]) OR "report a case"[tiab] OR ("report*"[tiab] AND ("ambulatory care facilities"[MeSH Terms] OR ("ambulatory"[tiab] AND "care"[tiab] AND "facilities"[tiab]) OR "ambulatory care facilities"[tiab] OR "clinic"[tiab] OR "clinic s"[tiab] OR "clinical"[tiab] OR "clinically"[tiab] OR "clinicals"[tiab] OR "clinics"[tiab] OR "patient*"[tiab])) OR "reported case"[tiab] OR "clinical presentation*"[tiab] OR "patient management"[tiab] OR "infected patient*"[tiab])	3,734,074 29.10.2021	*Case report definition* 1. Filter obtained from the National Library of Medicine. Section article filters. Filter name: LitCCaseReport. https://pubmed.ncbi.nlm.nih.gov/help/#publication-types 2. *Filter modified: [All Fields] changed to [tiab]*
#22	"Mental Health"[Mesh] OR "Depression"[Mesh] OR "Depressive Disorder"[Mesh] OR "Anxiety"[Mesh] OR "Anxiety Disorders"[Mesh]	393,102 29.10.2021	*Mental health definition [MeSH terms]*
#23	mental health[tiab] OR prevalence of depression[Title/Abstract] OR ″Psychosocial Impact″[tiab] OR ″Psychological Outcomes”[tiab] OR "Depressi*"[tiab] OR Melancholia*[tiab] OR "Anxiety"[tiab] OR Angst[tiab] OR Nervousness[tiab] OR Hypervigilance[tiab] OR Anxiousness[tiab] OR Anxieties[tiab]	683,353 29.10.2021	*Mental Health definition [terms title/abstract/keywords]*
#24	(#22) OR (#23)	790,677 29.10.2021	*Mental Health definition [MeSH Terms] + [terms title/abstract/keywords]*
#25	(#7) OR (#10) OR (#13)	6,063,073 29.10.2021	*Joining Indicators*
#26	(#1) AND (#4) AND ((#16) OR (#19)) AND (#25)	4,655 29.09.2021	*Disease + Type of study + Type of population (#16 OR #19) + Indicators*
#27	(#26) NOT preprint[pt]	4,556 *29*.10.2021	*Preprint definition* 1. Preprint filter obtained from the National Library of Medicine. https://pubmed.ncbi.nlm.nih.gov/help/#publication-types

			Exclusion criteria: preprints
#28	(#27) NOT (#20)	3667 29.10.2021	*Exclusion criteria: RCT*
#29	(#28) NOT (#21)	2638 29.10.2021	*Exclusion criteria: case reports*
#30	(#29) NOT (#24)	2278 *29.10.2021*	*Exclusion criteria: mental health prevalence*

Steps applied for the EMBASE Search Strategy
Search interface: embase.com

Date of search: 29.10.2021

Search	*Most Recent Queries*	*results*	*comment*
#1	*('coronavirus disease 2019'/exp OR 'covid 19' OR 'Coronavirus infection'/exp OR 'Coronavirinae'/exp OR 'Severe acute respiratory syndrome coronavirus 2'/exp OR '2019nCoV' OR 'corona virus*' OR 'coronavirus*' OR 'coronovirus*' OR '2019-nCoV' OR 'cov 2' OR '2019-nCoV' OR 'cov2' OR 'nCov 2019' OR 'nCoV' OR 'covid 19' OR 'COVID19' OR 'SARS-CoV-2' OR 'SARS2' OR ((19:ab,ti OR 2019:ab,ti OR '2019 ncov' OR beijing OR china OR 'covid 19' OR epidem*:ab,ti OR epidemic* OR (epidemies OR epidemy) OR new:ab,ti OR novel:ab,ti OR pandem* OR 'sars-cov-2' OR shanghai OR wuhan) AND ('Coronavirus infection'/exp OR 'Coronavirinae'/exp OR coronavirus* OR 'corona virus*' OR cov:ab,ti OR 'pneumonia virus*':ab,ti))) AND ([1-1-2020]/sd NOT [1-7-2021]/sd AND [english]/lim AND [embase]/lim NOT ([embase]/lim AND [medline]/lim) AND ([humans]/lim NOT [animals]/lim))*	*34,722* *29.10.2021*	*Disease definition* 1. *Search used from* https://doi.org/10.1111/acem.14048 *Data supplement s1 appendix in acem14048-sup-0001-datasuppls1.pdf* 2. *Ruled out Medline papers to avoid duplicates already retrieved in the PubMed search.* 3. *Replaced: “AND [humans]/lim” by “AND ([animals]/lim NOT [humans]/lim)” for human studies based on Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from http://training.cochrane.org/handbook, Chapter 2, section 6.4. cited in* https://bibliogetafe.com/2018/04/23/filtro-de-busqueda-para-estudios-en-humanos/
#2	'cross-sectional study'/exp OR 'case control study'/exp OR 'cohort analysis'/exp OR 'retrospective study'/exp OR 'follow up'/exp OR 'longitudinal study'/exp OR 'prospective study'/exp OR	*4,181,113* *29.10.2021*	*Study definition [Emtree Terms]*

	'seroepidemiology'/exp OR 'observational study'/exp		
#3	'epidemiological stud*':ti,ab,kw OR 'epidemiologic stud*':ti,ab,kw OR 'cross?sectional':ti,ab,kw OR 'disease frequency survey':ti,ab,kw OR 'case?control':ti,ab,kw OR 'control study':ti,ab,kw OR 'case?comp*':ti,ab,kw OR 'case?refer*':ti,ab,kw OR 'case?base':ti,ab,kw OR 'cohort':ti,ab,kw OR 'concurrent stud*':ti,ab,kw OR 'retrospective stud*':ti,ab,kw OR 'retrospective design*':ti,ab,kw OR 'follow?up':ti,ab,kw OR 'longitudinal':ti,ab,kw OR 'prospective stud*':ti,ab,kw OR 'prospective design*':ti,ab,kw OR 'prospective method*':ti,ab,kw OR 'seroepidemiolog*':ti,ab,kw OR 'sero-epidemiolog*':ti,ab,kw OR 'serogroup epidemiology':ti,ab,kw OR 'serologic epidemiology':ti,ab,kw OR 'serological epidemiology':ti,ab,kw OR 'serotype epidemiology':ti,ab,kw OR 'serotypic epidemiology':ti,ab,kw OR 'ecological study':ti,ab,kw OR 'ecological studies':ti,ab,kw OR 'ecological design':ti,ab,kw OR 'ecological designs':ti,ab,kw OR observational:ti,ab,kw	*3,861,148 29.10.2021*	*Study definition – [terms title/abstract/keywords]*
#4	#2 OR #3	5,373,407 *29.10.2021*	*Study definition [Emtree Terms] + [terms title/abstract/keywords]*
#5	'morbidity'/exp	*402,372 29.10.2021*	*Indicator: Morbidity [Emtree Terms]*

#6	'r0':ti,ab,kw OR 'basic reproductive number':ti,ab,kw OR 'time-varying reproduction number':ti,ab,kw OR 'reproduction number':ti,ab,kw OR 'prevalence*':ti,ab,kw OR 'incidence*':ti,ab,kw OR 'morbidit*':ti,ab,kw OR 'attack rate*':ti,ab,kw OR 'secondary attack':ti,ab,kw OR 'person-time rate*':ti,ab,kw OR 'person time rate*':ti,ab,kw	*2,720,490 29.10.2021*	*Indicator: Morbidity [terms title/abstract/keywords]*
#7	#5 OR #6	*2,804,713 29.10.2021*	*Indicator: Morbidity [Emtree Terms] + [terms title/abstract/keywords]*
#8	'mortality'/exp	*1,254,233 29.10.2021*	*Indicator: Mortality [Emtree Terms]*
#9	‘mortalit*’:ti,ab,kw OR ‘case-fatality rate’:ti,ab,kw OR ‘case fatality rate’:ti,ab,kw OR ‘death rate*’:ti,ab,kw OR ‘crude death’:ti,ab,kw OR ‘excess deaths’:ti,ab,kw OR ‘excess all cause deaths’:ti,ab,kw OR ‘excess number of deaths’:ti,ab,kw OR ‘excess COVID-19-related deaths’:ti,ab,kw OR ‘infection fatality r*’:ti,ab,kw OR ‘number covid-19 deaths’:ti,ab,kw OR ‘confirmed covid-19 deaths’:ti,ab,kw OR ‘deaths hospitalization ratio’:ti,ab,kw OR ‘survival’:ti,ab,kw OR ‘death toll’:ti,ab,kw OR ‘fatal outcome’:ti,ab,kw	*2,676,744 29.10.2021*	*Indicator: Mortality [terms title/abstract/keywords]*
#10	#8 OR #9	3,007,982 *29.10.2021*	*Indicator: Mortality [Emtree Terms] + [terms title/abstract/keywords]*
#11	'hospital admission'/exp OR 'intensive care unit'/exp OR 'artificial ventilation'/exp OR 'hospital patient'/exp OR 'risk assessment'/exp OR 'outcome assessment'/exp	1,949,505 29.10.2021	*Indicator: Severity [Emtree Terms]*
#12	‘acute respiratory infection’:ti,ab,kw OR ‘Patient Admi*’:ti,ab,kw OR ‘Voluntary Admission*’:ti,ab,kw OR	4,283,391 29.10.2021	*Indicator: Severity [terms title/abstract/keywords]*

	'hospital Admi*':ti,ab,kw OR 'intensive care':ti,ab,kw OR 'Respiratory Care Unit*':ti,ab,kw OR 'Recovery room*':ti,ab,kw OR 'close attention unit':ti,ab,kw OR 'critical care unit':ti,ab,kw OR 'intensive therapy unit':ti,ab,kw OR 'intensive treatment unit':ti,ab,kw OR 'special care unit':ti,ab,kw OR 'Respiration, Artificial':ti,ab,kw OR 'Artificial Respirat*':ti,ab,kw OR 'Ventilation, Mechanical':ti,ab,kw OR 'mechanical ventilation*':ti,ab,kw OR 'Interactive Ventilatory':ti,ab,kw OR 'Ventilatory Support':ti,ab,kw OR 'Ventilatory Assist':ti,ab,kw OR 'Assist Ventilation':ti,ab,kw OR 'Ventilation, Proportional Assist':ti,ab,kw OR 'invasive ventilation':ti,ab,kw OR 'controlled respiration':ti,ab,kw OR 'controlled ventilation':ti,ab,kw OR 'mechanical respiration':ti,ab,kw OR 'mechanical ventilation':ti,ab,kw OR 'Inpatient*':ti,ab,kw OR 'in-patient*':ti,ab,kw OR 'Hospitalised patient*':ti,ab,kw OR 'hospitalized patient*':ti,ab,kw OR 'in-hospital patient*':ti,ab,kw OR 'Risk Adjustment*':ti,ab,kw OR 'risk analysis':ti,ab,kw OR 'risk evaluation':ti,ab,kw OR 'safety assessment':ti,ab,kw OR 'Case-Mix Adjustment*':ti,ab,kw OR		

	‘Case Mix Adjustment*’:ti,ab,kw OR ‘Outcomes Assessment*’:ti,ab,kw OR ‘Outcome Assessment*’:ti,ab,kw OR ‘Outcomes Research’:ti,ab,kw OR ‘Outcome Stud*’:ti,ab,kw OR ‘Outcome Measure*’:ti,ab,kw OR ‘severity’:ti,ab,kw OR ‘case-hospitalization ratio’:ti,ab,kw OR ‘proportion of hospitalization’:ti,ab,kw		
#13	#11 OR #12	5,385,924 29.10.2021	*Indicator: Severity [Emtree Terms] + [terms title/abstract/keywords]*
#14	*'population health'/exp*	4,048 29.10.2021	*General population definition [Emtree Terms]*
#15	‘Population Health’:ti,ab,kw OR ‘populational health’:ti,ab,kw OR ‘general population’:ti,ab,kw OR ‘population stud*’:ti,ab,kw OR ‘population cohort study’:ti,ab,kw OR ‘population-based’:ti,ab,kw OR ‘community-based’:ti,ab,kw OR ‘community dwelling’:ti,ab,kw OR ‘Nationwide’:ti,ab,kw OR ‘national cohort’:ti,ab,kw OR ‘million people’:ti,ab,kw OR ‘federal state*‘:ti,ab,kw OR ‘state level‘:ti,ab,kw OR ‘*region**’:ti,ab,kw OR ‘countr*’:ti,ab,kw OR ‘county’:ti,ab,kw OR ‘counties’:ti,ab,kw OR ‘nation*’:ti,ab,kw	3,972,922 29.10.2021	*General population definition [terms title/abstract/keywords]*
#16	*#14 OR #15*	3,973,519 29.10.2021	*General population definition [Emtree Terms] + [terms title/abstract/keywords]*
#17	'nursing home'/exp OR 'home for the aged'/exp	65,045 29.10.2021	*Nursing homes definition [Emtree Terms]*
#18	‘Nursing Home*’:ti,ab,kw OR ‘convalescence home*’:ti,ab,kw OR ‘convalescence hospital*’:ti,ab,kw OR ‘extended care	76,049 29.10.2021	*Nursing homes definition [terms title/abstract/keywords]*

	facilit*':ti,ab,kw OR 'long term care facilit*':ti,ab,kw OR 'skilled nursing facilit*':ti,ab,kw OR 'Homes for the Aged':ti,ab,kw OR 'Geriatric facilit*':ti,ab,kw OR 'Old Age Home*':ti,ab,kw OR 'long-term care':ti,ab,kw OR 'aged care home*':ti,ab,kw OR 'aged care facilit*':ti,ab,kw OR 'continuing care retirement center*':ti,ab,kw OR 'geriatric homes*':ti,ab,kw OR 'home? for the elderly':ti,ab,kw OR 'homes for the aged':ti,ab,kw OR 'housing for the elderly':ti,ab,kw OR 'old people home*':ti,ab,kw OR 'retirement center*':ti,ab,kw OR 'retirement centre*':ti,ab,kw OR 'retirement home*':ti,ab,kw OR 'senior residence facility*':ti,ab,kw		
#19	#17 OR #18	*100,778* *29.10.2021*	*Nursing homes definition [Emtree Terms] + [terms title/abstract/keywords]*
#20	('clinical':ab,ti,kw AND 'trial':ab,ti,kw) OR 'clinical trial (topic)'/exp OR 'clinical trial':it OR 'random*':ab,ti,kw OR 'randomization'/exp OR 'therapeutic use'/exp	2,209,897 *29.10.2021*	*RCT definition* 1. Based on RCT filter obtained from the National Library of Medicine. Optimized for sensitive/broad; sensitive/specific 99%/70%. https://pubmed.ncbi.nlm.nih.gov/help/#publication-types. Search filters based on the work of Haynes RB et al. doi: 10.1136/bmj.38068.557998
#21	*('case report*' OR ('case reports':it OR 'case reports') OR 'report a case' OR ('report*' AND ('outpatient department'/exp OR ('ambulatory' AND 'care' AND 'facilities') OR 'ambulatory care facilities' OR 'clinic' OR 'clinic s' OR 'clinical' OR 'clinically' OR 'clinicals' OR 'clinics' OR 'patient*')) OR 'reported case' OR 'clinical presentation*' OR 'patient*	5,839,019 *29.10.2021*	*Case report definition* 1. Filter obtained from the National Library of Medicine. Section article filters. Based on LitCCaseReport filter https://pubmed.ncbi.nlm.nih.gov/help/#publication-types

	management' OR 'infected patient')*		
#22	'mental health'/exp OR 'depression'/exp OR 'anxiety'/exp OR 'anxiety disorder'/exp	1,001,057 29.10.2021	*Mental health definition [Emtree terms]*
#23	'mental health':ti,ab,kw OR 'prevalence of depression':ti,ab,kw OR 'Psychosocial Impact':ti,ab,kw OR 'Psychological Outcomes':ti,ab,kw OR 'Depressi*':ti,ab,kw OR 'Melancholia*':ti,ab,kw OR 'Anxiety':ti,ab,kw OR 'Angst':ti,ab,kw OR 'Nervousness':ti,ab,kw OR 'Hypervigilance':ti,ab,kw OR 'Anxiousness':ti,ab,kw OR 'Anxieties':ti,ab,kw	946,706 29.10.2021	*Mental Health definition [terms title/abstract/keywords]*
#24	#22 OR #23	1,324,453 29.10.2021	*Mental Health definition [Emtree Terms] + [terms title/abstract/keywords]*
#25	#7 OR #10 OR #13	8,736,136 29.10.2021	*Joining Indicators*
#26	#1 AND #4 AND (#16 OR #19) AND #25	1,855 *29.10.2021*	*Disease + Type of study + Type of population (#16 or #19) + Indicators*
#27	#26 NOT #20	1684 29.10.2021	*Exclusion criteria: RCT*
#28	#27 NOT #21	956 29.10.2021	*Exclusion criteria: case reports*
#29	#28 NOT #24	856 *29.10.2021*	*Exclusion criteria: mental health prevalence*

WHO COVID-19 Global literature on coronavirus disease strategy
Search interface: search.bvsalud.org

Date of search: 02.11.2021

Full Search using WHO COVID-19 Global literature on coronavirus disease:

((tw:("Epidemiological Studies")) OR (tw:("Epidemiological Study")) OR (tw:("Epidemiologic Study")) OR (tw:("cross-sectional")) OR (tw:("cross sectional")) OR (tw:("Disease Frequency" survey*)) OR (tw:("case-control")) OR (tw:("case control")) OR (tw:(case-comp*)) OR (tw:(case comp*)) OR (tw:(case-refer*)) OR (tw:(case refer*)) OR (tw:("Case-Base")) OR (tw:("Case Base")) OR (tw:(cohort)) OR (tw:(concurrent stud*)) OR (tw:(longitudinal)) OR (tw:("follow up")) OR (tw:(follow-up)) OR (tw:(prospective stud*)) OR (tw:(prospective design*)) OR (tw:(retrospective stud*)) OR (tw:(retrospective design*)) OR (tw:(seroepidemiolog*)) OR (tw:(sero-epidemiolog*)) OR (tw:("serogroup epidemiology")) OR (tw:("serologic epidemiology")) OR (tw:("serological epidemiology")) OR (tw:("serotype epidemiology")) OR (tw:("serotypic epidemiology")) OR (tw:(ecological stud*)) OR (tw:(ecological design*)) OR (tw:(observational)) OR (type_of_study:("observational_studies")) OR (tw:(incidence stud*)) OR (tw:(prevalence stud*)) OR (tw:("Controlled Before-After" stud*)) OR (tw:("Interrupted Time Series"))) AND ((tw:("Population Health")) OR (tw:("populational health")) OR (tw:("general population")) OR (tw:(population stud*)) OR (tw:("population cohort study")) OR (tw:("population-based")) OR (tw:("community-based")) OR (tw:("community dwelling")) OR (tw:(Nationwide)) OR (tw:("national cohort")) OR (tw:("million people")) OR (tw:(federal state*)) OR (tw:("state level")) OR (tw:(region*)) OR (tw:(countr*)) OR (tw:(county)) OR (tw:(counties)) OR (tw:(nation*)) OR (tw:(Nursing Home*)) OR (tw:(convalescence home*)) OR (tw:(convalescence hospital*)) OR (tw:("extended care" facilit*)) OR (tw:("long term care" facilit*)) OR (tw:("skilled nursing" facilit*)) OR (tw:("Homes for the Aged")) OR (tw:(Geriatric facilit*)) OR (tw:("Old Age" Home*)) OR (tw:("long-term care")) OR (tw:("aged care" home*)) OR (tw:("aged care" facilit*)) OR (tw:("continuing care retirement" center*)) OR (tw:(geriatric homes*)) OR (tw:(home? "for the elderly")) OR (tw:("homes for the aged")) OR (tw:("housing for the elderly")) OR (tw:("old people" home*)) OR (tw:(retirement center*)) OR (tw:(retirement centre*)) OR (tw:(retirement home*)) OR (tw:("senior residence" facility*))) AND ((tw:(R0)) OR (tw:("Basic reproductive number")) OR (tw:(reproduction number)) OR (tw:(prevalence*)) OR (tw:(incidence*)) OR (tw:(morbidit*)) OR (tw:(attack rate*)) OR (tw:("Secondary Attack")) OR (tw:("Person-time" Rate*)) OR (tw:("Person time" Rate*)) OR (tw:(mortalit*)) OR (tw:("case-fatality" rate*)) OR (tw:("case fatality" rate*)) OR (tw:(death rate*)) OR (tw:("crude death")) OR (tw:("excess deaths")) OR (tw:("excess all cause deaths")) OR (tw:("excess number of deaths")) OR (tw:("excess COVID-19-related deaths")) OR (tw:("infection fatality" r*)) OR (tw:("number covid-19 deaths")) OR (tw:("confirmed covid-19 deaths")) OR (tw:("deaths hospitalization ratio")) OR (tw:(survival)) OR (tw:("death toll")) OR (tw:("fatal outcome")) OR (tw:("acute respiratory infection")) OR (tw:(Patient Admi*)) OR (tw:(Voluntary Admission*)) OR (tw:(hospital Admi*)) OR (tw:(intensive care)) OR (tw:("Respiratory Care" Unit*)) OR (tw:(Recovery room*)) OR (tw:("close attention unit")) OR (tw:("critical care unit")) OR (tw:("intensive therapy unit")) OR (tw:("intensive treatment unit")) OR (tw:("special care unit")) OR (tw:(Respiration Artificial)) OR (tw:(Artificial Respirat*)) OR (tw:(Ventilation Mechanical)) OR (tw:(mechanical ventilation*)) OR (tw:("Interactive Ventilatory")) OR (tw:("Ventilatory Support")) OR (tw:("Ventilatory Assist")) OR (tw:("Assist Ventilation")) OR (tw:("Ventilation Proportional Assist")) OR (tw:("invasive ventilation")) OR (tw:("controlled respiration")) OR (tw:("controlled ventilation")) OR (tw:("mechanical respiration")) OR (tw:("mechanical ventilation")) OR (tw:(Inpatient*)) OR (tw:(in-patient*)) OR (tw:(Hospitalised patient*)) OR (tw:(hospitalized patient*)) OR (tw:(in-hospital patient*)) OR (tw:(Risk Adjustment*)) OR (tw:("risk analysis")) OR (tw:("risk evaluation")) OR (tw:("safety assessment")) OR (tw:("Case-Mix" Adjustment*)) OR (tw:("Case Mix" Adjustment*)) OR (tw:(Outcomes Assessment*)) OR (tw:(Outcome Assessment*)) OR (tw:("Outcomes Research")) OR (tw:(Outcome Stud*)) OR (tw:(Outcome Measure*)) OR (tw:(severity)) OR (tw:("case-hospitalization ratio")) OR (tw:("proportion of hospitalization"))) AND la:("en") AND year_cluster:("2021" OR "2020") AND NOT db:("MEDLINE" OR "EMBASE") AND NOT type:("preprint") AND NOT ((clinical AND trial) OR mj:("Randomized Controlled Trials as Topic") OR type_of_study:("clinical_trials") OR random* OR randomization OR "therapeutic use") AND NOT ((case AND report*) OR type_of_study:("case_reports") OR "report a case" OR (report* AND ("outpatient department" OR (ambulatory AND care AND facilities) OR "ambulatory care facilities" OR clinic OR "clinic s" OR clinical OR clinically OR clinicals OR clinics OR patient*)) OR "reported case" OR (clinical AND presentation*) OR "patient management" OR (infected AND patient*)) AND NOT ((tw:("Psychological Outcomes")) OR (tw:("mental health")) OR (tw:("prevalence of depression")) OR (tw:("Psychosocial Impact")) OR (tw:(Depressi*)) OR (tw:(Melancholia*)) OR (tw:(Anxiety)) OR (tw:(Angst)) OR (tw:(Nervousness)) OR (tw:(Hypervigilance)) OR (tw:(Anxiousness)) OR (tw:(Anxieties)) OR mj:("Mental Health" OR "Depression" OR "Depressive Disorder"OR "Anxiety" OR "Anxiety Disorders"))

3. Researchers involved in the selection of sources of evidence

- Teresa Valero Gaspar (TVG). Spain. Health Institute Carlos III (ISCIII)
- Cesar Garriga (CG). Spain. Health Institute Carlos III (ISCIII)
- Martin Thissen (MT). Germany. Robert Koch Institute (RKI).
- Matej Vinko (MV). Slovenia. National Institute of Public Health (NIJZ).
- Péter Bezzegh (PB). Hungary. National Institute for Health Services (OFKO).
- Anda Curta (AC). Romania. National Institute of Public Health (INSP).
- Petru Sandru (PS). Romania. National Institute of Public Health (INSP).*
- Jane Idavain (JI). Estonia. National Institute for Health Development (TAI).
- Richard Pentz (RP). Austria. Austrian National Public Health Institute (GÖG).
- Šeila Cilović-Lagarija (SCL). Bosnia and Herzegovina. Institute of Public Health of the Federation of BiH (FbiH).
- Anes Jogunčić (AJ). Bosnia and Herzegovina. Institute of Public Health of the Federation of BiH (FbiH).
- Šárka Dankova (SD). Czech Republic. Institute of Health Information and Statistics of the Czech Republic (UZIS).
- Brigid Unim (BU). Italy. Italian National Institute of Health (ISS).
- Luigi Palmieri (LP). Italy. Italian National Institute of Health (ISS).
- Rodrigo Feteira-Santos (RFS). Portugal. Lisbon School of Medicine-Lisbon University (FMUL).
- Jakov Vuković (JV). Croatia. Croatian Institute of Public Health (HZJZ).*

*PS and JV were not involved during the screening phase

4. Data extraction of included papers

Paper (First author, author country, reference)	Country/ administrative area	Study period (mmm/yyyy)	Study design* (Ecological, Cross-sectional, Case-controls, Cohort)	Sample/Population (general population, patients, hospitalised patients, the dead, residents care homes, older)	Methods/statistical analysis (descriptive, inferential statistics)	Indicators (category, indicator**)	Exclusion criteria***	SARS-CoV-2 infection diagnosis is not clear
Surname and Name initials of the first author, c, **add with your reference manager software a reference number linked to a list of references at the end of this document**)			Type one of the listed items: -Ecological -Cross- sectional -Case-controls -Cohort	Type one of the listed items: -general population -patients -hospitalised patients -the dead -residents care homes -older	1.Type descriptive or/and multivariable. 2.Type **specific methods** e.g.: -Compartmental model (SIR/SEIR…) -Negative binomial regression -Cox regression . . .	**1.Type category** of indicator: 1.1.Morbidity 1.2.Mortality 1.3.Severity 1.4.Composite **2.Type indicator**		☐ (tick the checkbox if YES)
								☐

*** Study design definitions:**

Complete using one of the following categories: ecological, cross-sectional, case-controls or Cohorts.

- Seroprevalence: it can be a cross-sectional or a cohort study.
    - A seroprevalence survey or study is cross sectional if is not possible to follow up a participant between time points, or if there is only one time point or round.
    - A seroprevalence study is a cohort study if a participant can be followed between time points (e.g. the allows to detect seroconversion between rounds, participant negative in the first round and turning out positive in a posterior round)
- Ecological: Data are aggregated for analysis. We consider time series and trend analysis as ecological studies.
- Cohort: Longitudinal studies of follow up studies. An individual is followed up since a starting point till an outcome. At least there are two time points per individual. However, there are studies using participants in a cohort for case control analysis (nested case-control studies) or for a cross–sectional analysis.
- Cross-sectional: Just one time point included for analysis. Sometimes, consecutives time points but we cannot identify the patient between time points.
- Case controls: These studies investigate the exposure instead the outcome.

If it would be difficult to classify the study in one of the categories it will be typed the study design as reported in the paper. If it was not reported, then it will be typed “Not clear” for the study design cell.

**** Health Indicators/measures (examples):**

- Morbidity: R_0- basic reproductive number, R_t-time-varying reproduction number, reproduction number, prevalence, incidence, attack rate, secondary attack, person-time rate, Incidence per million people of cases, % positive among tested, Prevalence ratio of antibodies against SARS-CoV-2, test-retest positivity (defined as positive at baseline and positive at the 1-month follow-up), incidence of new COVID-19 exposure (defined as negative at baseline and positive at the 1-month follow-up)

- Mortality (during hospitalization, delayed mortality): case-fatality rate, death rate, excess deaths, excess all cause deaths, excess number of deaths, infection fatality rate, number covid-19 deaths, confirmed covid-19 deaths, deaths hospitalization ratio, death toll, proportion of in-hospital deaths in relation to the total number of patients hospitalized with COVID-19, Number of deaths per million, % died in the emergency room at the time of presentation,
- Severity: patient admission to hospital, admission to intensive care unit (ICU), inpatients, admission to respiratory care unit, recovery room, close attention unit, critical care unit, intensive therapy unit, intensive treatment unit, special care unit, artificial respiration, mechanical ventilation, ventilatory support, invasive ventilation, controlled respiration, controlled ventilation, mechanical respiration, case-hospitalization ratio, proportion of hospitalization, % High-flow nasal cannula oxygen in relation to the total number of patients hospitalized with COVID-19, % Non-invasive mechanical ventilation in relation to the total number of patients hospitalized with COVID-19, % Invasive mechanical ventilation in relation to the total number of patients hospitalized with COVID-19, % Complications in relation to the total number of patients hospitalized with COVID-19, % Intensive care admission in relation to the total number of patients hospitalized with COVID-19, Days of hospitalization for patients with COVID-19, Number of admissions per million
- Composite: admission to intensive care unit (ICU) or in-hospital death (Mortality + Severity indicator)

NOT consider Heath indicators (examples):

- absolute numbers
- number of emergency visits per day for any reason
- Days from onset to admission
- % alive after hospital discharge
- proportion of patients living in nursing homes prior to admission

***Stepping process for applying the exclusion criteria:

1. Check in the whole paper

☐ Not English written

☐ Not an original research (i.e. editorial, protocol, conference abstract, grey literature, or no original results)

2. Check in M&M (and Results section)

☐ Study does not contain information on their calculation

For studies not reporting any calculation of indicators. Some papers included indicators calculated in external websites. Some of the websites providing their calculation on indicators were:

- https://www.worldometers.info/ (worldometer team)
- https://coronavirus.jhu.edu/map.html (John Hopkins University)
- https://ourworldindata.org/ (University of Oxford)

☐ Study does not have information of data sources used to get data for calculation

☐ Study does not consider health indicators

3. Check exclusion criteria from the previous phase

☐ Unrelated topic (e.g. an indirect impact indicator)

☐ Not a population-based study (representative individuals of the general population). However, nursing homes, homes for the aged and inpatients (hospitalised patients) will be included.

☐ Subpopulation (e.g. paediatric patients, patients having a condition without comparison with general population, pregnant women, healthcare workers, students, US veterans, etc). However, elderly will be included.

☐ Duplicate

☐ Prognostic studies (synonyms: forecasting studies, predictive models, prospective studies, projections and predictions, foresight, future)

4. Other criteria for exclusion

☐ Clinical trial or intervention study

☐ Qualitative study

☐ The study is a continuation of a previous study. Studies will be selected among those providing more information regarding health indicators. If there were several studies related but using at least one different indicator, it will keep all those papers.

5. Google Form questionnaire administered to collaborators for health indicator extraction

See supplementary material S2

6. Google Form questionnaire administered to collaborators for incluiding policy documents and decision tools

See supplementary material S3

I. Chapter 3 – subtask 5.1.3

Authors: Teresa Valero-Gaspar[1], Cesar Garriga[1], Matej Vinko[2], Rodrigo Feteira-Santos[3], Luigi Palmieri[4], Brigid Unim[4], Šárka Daňková[5], Martin Thiβen[7], Richard Pentz[8], Jakov Vuković[9,] and Petru Sandu[10], Asunción Díaz[1], Carmen Rodríguez Blázquez[1], Maria João Forjaz[1].

Affiliation: [1] National Centre for Epidemiology. Carlos III Health Institute, Madrid, Spain

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[3] Faculdade de Medicina, Universidade de Lisboa (FMUL), Lisbon, Portugal

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[5] Institute of Health Information and Statistics of the Czech Republic (UZIS), Prague, Czech Republic

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[8] Austrian National Public Health Institute (GÖG), Vienna, Austria

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INDIRECT IMPACT OF COVID-19 PANDEMIC ON HEALTH, WELLBEING AND HEALTHCARE: A NARRATIVE REVIEW

A. Introduction

The COVID-19 pandemic had significant effects on health across the world. Patients suffering from non-COVID-19 conditions faced disruption in their treatment. Hospitals delayed routine operations (1,2) for planned care (3) and public health systems subsequently issued guidance to ensure patients with cancer do not face higher risks (4). Lai et al. (5) estimated that this could result in an extra 18,000 deaths due to cancer in England (UK), Venkatesulu et al. (6) estimated a higher incidence of severe events for patients with cancer in a metaanalysis with 26 studies. Furthermore, in June 2020, direct access to primary care was limited, with general practitioners (GPs) utilising telephone and video appointments instead of face-to-face visits (7), and visits to urgent and emergency care services dropped significantly since the pandemic started (8). Thus, important medical attention might not have been sought. Some patients required emergency care as their conditions worsen due to the lack of treatment (9,10), while hospitalisations for chronic conditions may also increase as people suffered the consequences of the social-distancing policies 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 (14,15). Second, it might neglect the health of some groups more vulnerable than others (those with underlying co-morbidities, children, homeless, women, pregnant, migrants and people with disabilities) (16). However, early evidence suggested there were large variations between groups. For example, regarding cancer deaths and other indirect deaths (including drug-related, alcohol-specific, 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 in England and Wales (17). The consequences of the COVID-19 restrictions affected unevenly across communities, with areas of higher deprivation and those with ethnic minorities bearing the brunt of COVID-19 (18).

Different types of indicators have been used to assess the indirect impact of the COVID-19 health crisis. Some examples are burden of non-COVID-19 diseases (19), life expectancy non attributable to COVID-19 disease, reduction or increase of chronic medication (20), delayed programmed surgeries (21) among other indicators. Three narrative reviews published in 2022 have described the impact of COVID-19 pandemic on chronic pain (22), mental health in general population and vulnerable groups (23) or maternal and child health services (24).

Our aim was to describe in a narrative review the main indicators used in the research literature that evaluates the indirect impact on health and wellbeing caused by the COVID-19 disease. Indicators were classified in two main groups considering important health areas indirectly affected by the COVID-19 pandemic: *health and wellbeing* (burden of disease, life expectancy, quality of life, cost of illness and mental health status) and *medical care disruptions for non-COVID-19 patients* (availability of specialised health care, delayed/cancelled programmed surgeries, primary care visits delay, reductions in visits and hospitalizations of non-COVID-19 patients with chronic condition, perinatal screening, cancer screening and screening of non-COVID-19 infectious diseases).

B. Methods

A literature search was conducted via PubMed with date parameters of January 2021 to November 2022. The selection criteria included studies published at peer-reviewed journals written in English. Country reports and policy briefs were not included. Grey literature such as conference proceedings, dissertations, abstracts, unpublished studies, and books were also excluded. Two reviewers carried out a search strategy for each topic in November 30th 2022. Each search strategy implemented a combination of key words with free text and Medical Subject Headings (MeSH) terms. Twelve collaborators from eleven European countries (Spain, Czech Republic, Croatia, Estonia, Italy, Romania, Portugal, Austria, Slovenia Italy and Germany) were allowed to modify search strategies to improve the chance to find relevant articles (Supplementary material S1).

Each collaborator involved in the selection of sources of evidence was assigned to retrieve information on health indicators measuring an important health area indirectly affected by the COVID-19 pandemic. Collected characteristics of indicators were: what it measured; why it was important; formula; a general description such as availability of data sources to implement the indicator, type of indicator or other considerations; strengths and weaknesses of the indicators. The characteristics and implementation of the indicator were discussed in comparison with its use in similar studies identified within the same search strategy. A summary of the papers included in this narrative review is presented in Supplementary material S2. All authors agreed on the final reference list.

In addition, a survey was developed using *Lime Survey* technology to gather indicators used in policy monitoring documents or decision tools and their characteristics (Supplementary material S3). Countries involved in the PHIRI project (in addition to the institutions collaborating to the subtask 5.1.3) were invited to identify experts who could complete the online form. Contributors were asked to identify whether the most frequently used health indicators to measure the indirect impact of COVID-19, as identified in the narrative review, were also present in their national policy monitoring documents or decision tools. The survey was released on March 17th and closed on March 31st 2023.

Contributors were encouraged to search for national documents using keywords such as “action plan”, “traffic light”, “algorithm”, “score”, “degrees”, “strategy”, “monitoring”, “tool” or “evaluation” and to complete one survey per selected document. They classified the aim of the documents as health promotion, prevention, or care; or a combination of these three categories. Data were extracted at the document level and debugged and structured using Stata v.17. Descriptive statistics were tabulated to show characteristics of documents and indicators, by absolute numbers and percentages.

C. Results

1. Indicators retrieved in policy monitoring documents or decision tools about indirect impact of COVID-19

Experts from Belgium, Croatia, Estonia, Germany, Latvia, the Netherlands and Romania completed the survey. Contributors from Austria and Serbia were not aware of any policy monitoring or decision tool that was systematically used to monitor the indirect effects of COVID-19. On the other hand, four documents were described from Estonia and three from Latvia and the Netherlands, respectively. A total of 15 questionnaires were completed. Most of the selected documents focused on “promotion and prevention of COVID-19 patients” (7, 46.7%) (Table 1). Three of the contributions were dashboards and other three were weekly reports (20.0%, respectively).

Table 1. Aim of the documents including indicators related to direct impact of COVID-19 retrieved from policy monitoring and decision tool documents

Aim of the document*	Number of documents (n)	%
Promotion	0	-
Prevention	2	13.3%
Care of COVID-19 patients	1	6.7%
Promotion and prevention	7	46.7%
Prevention and care	0	-
Promotion, prevention and care	1	6.7%

*Four contributions did not include any aim.

The characteristics of indicators related to indirect impact of COVID-19 retrieved from policy monitoring and decision tool documents are shown in Table 2. The indicators were expressed as proportions, counts (10, 66.7%, respectively) and rates (9, 60.0%) in similar proportions. Primary and secondary data sources were evenly used to obtain the data for the indicators of indirect impact (10, 66.7%).

Age and sex were the most used variables to stratify the indicators of indirect impact (12, 80.0%, respectively). Three contributors did not find any variable of stratification for the indicators. Large sample size was associated as the principal strength in the survey (9, 60.0%). Limitation of the indicators in the policy documents or decision tools poorly matched with those reported in the papers selected for the narrative review. One contributor reported limitations in the policy documents or decision tools apart from those enlisted in scientific papers: “lack of homogeneity of data imputation”, “lack of completeness and accuracy of some variables” and “change of international classification of diseases coding system across years”.

Table 2. Characteristics of indicators related to indirect impact of COVID-19 retrieved from policy monitoring and decision tool documents.

Type of indicators	Number of documents (n)	%
How indicators are mathematically expressed		
Proportion	10	66.7
Count	10	66.7
Rate	9	60.0
Data sources		
Primary data source	10	66.7
Secondary data source	10	66.7
Area of reference		
National/Country	13	86.7
Region/county/department	8	53.3
City/ municipality	1	6.7
Reference period		
Defined period (e.g. March 2020 to June 2020)	10	66.7
Month	6	40.0
Week	1	6.7
Day	1	6.7
Stratification by		
Age	12	80.0
Sex	12	80.0
Comorbidities	11	73.3
Geographic area (country, state, province, urban/rural...)	9	60.0
Socio economic status	1	6.7
Ethnicity	1	6.7
Strengths of indicators		
Large sample size	9	60.0
Data to calculate the indicator is easy to obtain	5	33.3
Assess several dimensions of the health status	3	20.0
Easy to calculate	1	6.7
Limitations of indicators		
Reduced sample size	1	6.7
Different time periods limiting comparisons between populations	1	6.7
Difficulties completing self-administered questionnaires in certain groups (e.g. people with mental disorders)	1	6.7
Measurement bias on data	1	6.7

2. Narrative review topics complemented with survey results

Part 1- Health and wellbeing

1.a Global Burden of Disease (GBD)

Burden of disease estimates the repercussion of illnesses and damages on a population. It integrates the years in good condition lost due to living with poor health (non-fatal burden) with the years of life lost due to early death (fatal burden)(25). The term burden of disease commonly outlines the total, cumulative effects of a certain medical condition or a range of harmful illnesses with regard to disabilities in a population. These effects consist of health, social attributes, and costs to society. The divergence between optimal circumstances, where everybody is free of disease and impairment, and the accumulated present 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, generated a procedure to appraise the global burden of disease; this was largely based on statistical calculations of *disability-adjusted life years (DALY)*, which combines the time lost due to early mortality and the time consumed living in poor health (26).

A study investigating elective surgical procedures in a hospital in the Netherlands estimated the impact on health of postponing those procedures (27). Survival data informed the model which included *years lived with disability summed to years of life lost (YLLs)* to premature death given the *disability adjusted life-years (DALY).* DALYs were used to evaluate the result of delays in surgery. The expected health outcomes with surgery at 2 weeks with the expected health outcomes at 52 weeks was compared to determine the health lost per 50 weeks, obtaining measure of urgency and later converted into *health lost per month delay*. This was used to rank the surgical procedures, where a high DALY/month indicated an urgent surgery.

Quality of data for this type of studies could be limited because surgical procedures evaluated are often part of standard clinical practice. Therefore, data might be biased (e.g., selection bias in the survival analysis of patients without treatment because patients opt for palliative care) or not available. The information retrieved from the results of the indicator's calculation allowed to inform a decision model supporting prioritization of surgical care in times of scarce surgical capacity, such as the COVID-19 pandemic.

We also identified the use of DALYs to quantify the impact of the COVID-19 pandemic on the prevalence and burden of major depressive disorder and anxiety disorders globally (28), finding that depressive and anxiety disorders increased during 2020 due to the COVID-19 pandemic. Other study implemented DALYs to project alcohol-associated liver disease (ALD) from 2020 to 2040 in the USA (29), concluding that a short-term increase in alcohol consumption during the COVID-19 pandemic could substantially increase long-term ALD-related morbidity and mortality.

Three policy monitoring documents or decision tools included the following indicators of burden of disease: *DALYs*, *years of life lost from mortality (YLLs)* and *years of healthy life lost due to disability (YLDs)* (20.0%, respectively) (Figure 1).

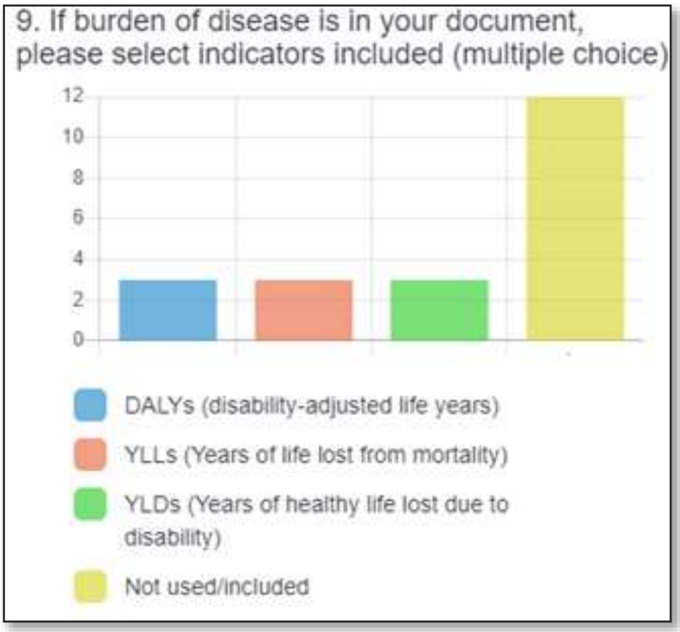

Figure 1. Indicators of burden of disease retrieved from national policy monitoring documents or decision tools about indirect impact of COVID-19.

<u>1.b Life expectancy</u>

The investigation of life expectancy in the framework of the COVID-19 crisis allowed researchers to contrast the cumulative effect of the pandemic in opposition to mortality in previous years as well as current trends trough distinct countries. This is possible because life expectancy is standardised and routinely monitored to register changes and differences in mortality (30). It allows the examination of the effect produced by the COVID-19 pandemic on survival controlling by the age distribution of the underlying populations (31). *Life expectancy at birth* is defined as how long, on average, a new born can expect to live, if current death rates do not change. Gains in life expectancy at birth can be attributed to a number of factors, including rising living standards, improved lifestyle and better education, as well as greater access to quality health services. This indicator is usually presented as a total and per gender and is measured in years (32). Other related measure is *life expectancy at age 65* (average number of years that a person at that age can be expected to live, assuming that age-specific mortality levels remain constant). The estimation of life expectancy can change by a fraction of a year depending on the calculation performed (33) that can vary slightly between countries.

In the context of the COVID-19 pandemic, a cohort study analysed all-cause death for England and Wales calculating *life expectancy* (average mortality) and the *variation in length of life* between individuals in a population (*lifespan inequality*) (30). The estimation of the number of deaths caused by the COVID-19 pandemic was considered to be crucial to know the impact of the disease. The authors evaluated the impact of the COVID-19 pandemic on life expectancy and lifespan inequality in 2020 using baseline number of deaths in the absence of COVID-19 and fitted models calculating excess deaths. *Life expectancy at birth* for women and men of 2020 was 82.6 and 78.7 years, with 0.9 and 1.2 years of life lost corresponding to the year 2019, respectively. *Lifespan inequality*, an indicator of the variation in ages at death, declined due to the raised mortality at older ages.

Life expectancy was also implemented to describe the impact of COVID-19 on the Black and Latino populations for the United States (31). Estimations on life expectancy were obtained at birth and at age 65 years for 2020, and global estimates were stratified by race and ethnicity. The authors found a reduction in US life expectancy at birth lower than any year since 2003 and a 0.87-years reduction in life expectancy at age 65 years. For Black and Latino populations the decline in life expectancy at birth was 2.10 and 3.05 years, respectively, while for Whites it was 0.68-years .

Another study analysed confirmed cases and determinants of the COVID-19 fatalities in 93 countries (34). A model for mortality including social indicators was projected, of which life expectancy at birth taken from the World Bank Open Data (35) was one of them. Life expectancy at birth was highly associated with the number of deaths caused by COVID-19 in countries having a low number of cases. They estimated that 1% increase in life expectancy was related to a reduction of deaths as a consequence of COVID-19 by 10.82%. The population over the age of 65 in the total population increases by 1% the number of deaths.

Three policy monitoring documents or decision tools used the indicator of *life expectancy at birth* (20.0%). One of those documents also included *life expectancy at age 65* (Figure 2).

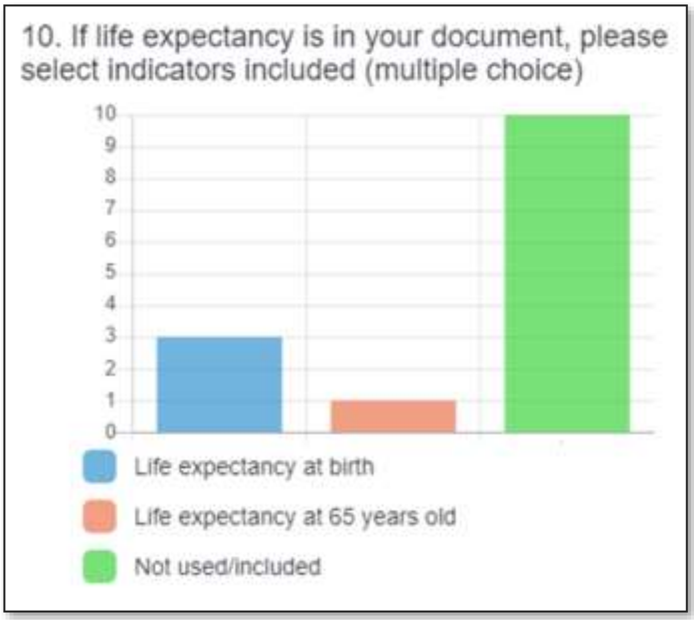

Figure 2. Indicators of life expectancy retrieved from national policy monitoring documents or decision tools about indirect impact of COVID-19.

1.c Quality of life

The COVID-19 can produce different outcomes and result in persistent symptoms which affect the daily life of infected individuals (36–39). Besides, measures taken to control the spread of the virus worldwide led to disruptions in daily activities of individuals at several levels (40,41). In this context, the assessment of the quality of life (QoL) and its association with the long-term health consequences of COVID-19 is required (42–45).

The long-term impact of COVID-19 infection or the pandemic countermeasures could lead to physical and mental health deterioration as well as impairment of health-related QoL (*HRQoL*) (40,41). Some measurement tools to evaluate the HRQoL (46) have been used for other purposes and are broadly validated in several languages. These instruments assess several dimensions of the *HRQoL*, including, physical, mental, social and emotional functioning (47). Some of the tools used to evaluate the impact of either the COVID-19 infection or the pandemic context in the *HRQoL* of populations, are the Medical Outcomes Study Short Form 36-item health survey (SF-36) (48), the EQ-5D (49–51), and the KIDSCREEN-10 index (52).

Verveen and colleagues used the SF-36 in a cohort study carried out in the municipal region of Amsterdam, the Netherlands, which followed individuals with a SARS-CoV-2 infection at months 1 and 12 after the laboratory confirmation, aiming to compare how infection severity impaired their own *HRQoL* at a short and long-term (53). One month after COVID-19 diagnosis, HRQL was significantly below population average on all SF-36 domains apart from general health and bodily pain among persons with mild COVID-19. After 12 months, individuals with mild COVID-19 had *HRQoL* within population standards. The study of O'Brien et al followed up hospitalised patients at 10-weeks, 6-months and 1-year after hospital discharge. The results allowed monitoring which patients or groups had a greater impairment of *HRQoL* assessed with the SF-36 after a COVID-19 infection to appraise the ability to return to previous levels of function (54) and how it is affected by contextual factors, such as public health control measures (53). The study of O'Brien et al did not find change in SF-36 scores in any domain during the study period, and scores persisted lower than population standards in the domains of physical functioning, energy/vitality, role limitations because of physical problems and general health.

Fernandes and colleagues (55) used the EQ-5D to evaluate the impact of COVID-19 infection on *HRQoL* among inpatients aged 18 years or older in a Portuguese university hospital, between the 30th and the 90th day after hospital discharge. Moderate to extreme problems (level ≥ 3) in some dimension of the EQ-5D-5L questionnaire were described in 29 patients (64.4%). The most affected dimension was usual activities (51.1% describing moderate to extreme problems), followed by anxiety/depression (37.8% with moderate to extreme problems) and pain/discomfort (31.1% with moderate to extreme problems). Kwon and colleagues (56) used the same instrument to assess the impact of quarantine on *HRQoL* of people aged 19 years and older living in Seoul Metropolitan City, South Korea, by comparing EQ-5D scores collected after the pandemic beginning with data which had been systematically collected before that and since 2008. The overall scores of the EQ-5D index were significantly higher in the group under quarantine during the COVID-19 pandemic (0.971 SD 0.064) than those before the pandemic (0.964 SD 0.079, Diff. 0.007 SD 0.101, p = 0.043).

A prospective, longitudinal cohort study was conducted at the intensive care unit (ICU) of an university hospital in Sweden to describe the burden of illness and its impact on health and working situation among former ICU patients treated for COVID-19. They were assessed at four and 12 months after discharge from intensive care using the EQ-5D (57). The findings presented no improvements between the first EQ-5D score and second follow-up for any of its domains: mobility, self-care, usual activity, pain/discomfort, anxiety/depression.

Finally, a cross-sectional study was conducted to evaluate the HRQoL of post-COVID-19 infected individuals in Belgium (58). The study participants were all post-COVID-19 infected persons who were active on social media platforms in the period June - August 2021. HRQoL was measured with EQ-5D-3L. Authors found low scores mainly affected by problems with activities and pain/discomfort between the dimensions of the EQ-5D-3L.

Using the KIDSCREEN 10, an instrument for assessing QoL in children, Barbieri and colleagues (2022)(59), studied how to safeguard children’s mental health in South Tyrol region, Italy, by evaluating the *HRQoL* of children attending that region’s public schools at the second year of the pandemic. A low *HRQoL* was self-reported by 33% of children and adolescents aged 11 to 19 years, while parents reported a low HRQoL for 31% of their children in this age group. The KIDSCREEN-10 was also used in a nationwide, population-based study with representative sample of children and adolescents (aged 7-17 years) in Germany measuring the *HRQoL* before and after the pandemic (60). 15.3% of children and adolescents reported low HRQoL before the pandemic (n = 146; based on weighted data of the BELLA study) vs 40.2% during the pandemic (n = 418; based on weighted self-reported data of the COPSY study). Children’s and adolescents’ needs were identified to inform policymakers, pediatric professionals, and parents on the mental health of children, which can be interpreted as a strength of this tool, as it reports findings from both children and their parents’ perspectives.

Assessing the population’s *HRQoL* requires using valid instruments, such as SF-36, EQ-5D or the KIDSCREEN-10 index, and collect primary data, which can be expensive and involve a large quantity of resources. In general, as these instruments need to be newly applied to evaluate the *HRQoL* after the exposure in question, i.e., a COVID-19 infection or pandemic context, the size of the studied sample or population could vary according to the available resources and question of investigation. It also led to different time settings of *HRQoL* assessments which impairs the reliability of results comparisons between different populations. Thus, the available data is not always enough for disaggregating as much as it is necessary to compare the HRQoL of all population's subgroups. When data collection involves self-administered method, some population's subgroups can be less likely to provide and complete the questionnaires, impairing comparisons between groups. Moreover, some HRQoL scales could not be appropriate for all populations. For example, applying the SF-36 is also not possible in people with mental disorders. KIDSCREEN-10 is measured as a single global score of HRQoL, which leads to the loss of information when compared, e.g., to other KIDSCREEN longer versions (61).

One of the policy monitoring documents or decision tools reported using the SF-36 scale. Other indicators of HRQoL not described in the narrative review were identified in the survey of policy monitoring documents and decision tools: *Involvement in various activities since the beginning of the COVID-19 pandemic, level of social involvement and isolation by gender (%), self-assessment of health status and access to health care* and *respondents' self-assessment of health and reported somatic and mental health disorders*.

1.d Cost of illness

COVID-19 can impact the ability to return to work and perform at normal capacity after the coronavirus infection, thus individual's productivity (62,63). Productivity loss could be defined in terms of presenteeism (not being able to work at normal capacity) and absenteeism (not being able to work at all) (63).

A cross-sectional study conducted in Belgium and the Netherlands (63) assessed the impact of COVID-19 pandemic on level of stress, *QoL*, medical resource use and productivity losses in the general population during the first 8 weeks of the coronavirus lockdown. The indicator *productivity losses* related to COVID-19 was described in terms of absenteeism and presenteeism and was recorded by the Productivity Cost Questionnaire - iPCQ. The authors calculated the mean value of lost production among respondents in paid profession per person per week. Lost paid work due to COVID-19 was calculated by multiplying the number of hours lost with the average age-related hourly income in a specific country. All costs were presented as weekly costs in euro.

A similar study was conducted to estimate the lost productivity cost of absenteeism due to COVID-19 in Iran among hospital staff (64). The monetary value for a working day among employees who were absent due to COVID-19 was multiplied by the number of missed workdays to estimate the *absenteeism cost*; all costs were expressed in US dollars. The monetary value for a working day was computed using current salaries, as in the study by van Ballegooijen et al., but the period considered by the current study was much longer (February-September, 2020).

Another study estimated the cost of absenteeism among healthcare workers in Brazil (62). The period investigated ranged from September 2014 to December 2020, thus including COVID-19 patients. As in previous studies, the *cost of absenteeism* was calculated by summing the "daily wage costs" according to the absent worker's job title for the relevant period. However, the cost of absenteeism did not include periods when workers were receiving sickness benefit, because in these cases wages (salaries) were not paid. The authors also calculated the "rate of absenteeism per year" by dividing the number of days absent in 1 year by the number of days that could have been worked. This rate takes into account the weekly number of hours worked and the worker's job title. The "total cost of absenteeism per year" was calculated using the formula:

$$Total\ cost\ of\ absenteeism = \left(\frac{montly\ wage}{montly\ workload\ in\ hours} \times\ daily\ workload\ in\ hours\right) \times days\ off\ work$$

The indicator *rate of absenteeism per year* was employed in one of the policy monitoring documents or decision tools. *Productivity loses* or *lost productivity cost due to absenteeism* indicators described in the narrative review were not found in the documents considered in the survey. The *Federgon index*, an indicator growth of temporary employment on a yearly basis, based on worked hours, was stated in one policy document.

1.e 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 (65,66). Such effects can be due to national lockdowns settled to contain virus spread, which result in isolation and family separation; panic and hysteria propagated from social media, scarcity of basic needs and financial losses, increasing fear and vulnerability due to the uncertainty of disease progression (65,66). Therefore, COVID-19 pandemic can increase the risk for new onset of mental health complications or exacerbation of pre-existing mental disorder(s) in general population and in vulnerable individuals with pre-existing conditions (67). To address the risks for mental health complications during the COVID-19 pandemic is, therefore, important also to allocate health resources and to reduce adverse consequences of the COVID-19 (67).

An observational study in Lithuania (67) described the association of pre-existing medical conditions (e.g., cardiovascular, pulmonary, obesity, diabetes, mental disorders or other) and self-perceived health status with the risk of mental health complications during the COVID-19 pandemic. Depressive symptom severity and, specifically with anxiety symptom severity measured by the

Generalized Anxiety Disorders-7 (GAD-7) score (68). An online survey was conducted from October 1 to December 20, 2020. The binary logistic regression analysis was used to explore the association of pre-existing conditions (yes vs. no) and anxiety symptoms (GAD-7 scores of ≥10) together with the other mental health complications. Pre-existing conditions and poor perceived health status were associated with increased risk for moderate to severe depressive and anxiety symptoms ($p=0.046$ and $p<0.001$ respectively).

The same indicator was used in a survey (May 2020 to February 2021) for pregnant women in Sweden to measure prevalence of *perinatal anxiety* (together with depression and acute stress reaction) in addition to their association with mental health outcomes in an observational cross-sectional study (69). Factors associated with mental health outcomes were analysed using multivariate logistic regression model. One fourth (n = 121, 25.7%) of participants displayed moderate to severe generalized anxiety symptoms (GAD-7 ≥ 10).

Finally, the *GAD-7 score indicator* was used in a single-centre study of home dialysis patients in Toronto to describe levels of anxiety and quality of life during the COVID-19 pandemic (65). In this case, most symptoms of anxiety and depression were experienced “some days” or “never” in more than 80% of respondents

The use of validated generic scales such as GAD-7 is an effective way of obtaining indicators of the impact of COVID-19 on mental health. They are easy-to-score and provide self-reported measures of core mental health disorders symptoms in a standardized manner. However, they are based on self-reports, evaluate only probable diagnoses that should be confirmed by other means, such as psychiatric interviews, and could not be appropriate for some groups of population (68,70,71).

The online survey described the use of the indicators *GAD-7* (4, 26.7%), *medication related to mental health condition* (2, 13.3%), and *changes in mental health resources utilisation* (1, 6.7%) identified in the narrative review. In addition, *psychological conditions during COVID-19 (%)*, *involvement in various activities since the beginning of the COVID-19 pandemic*, *level of social involvement and isolation by gender (%)* and *mental health measured by the General Health Questionnaire (12 item scale; GHQ-12)* were used in policy monitoring documents (Figure 3).

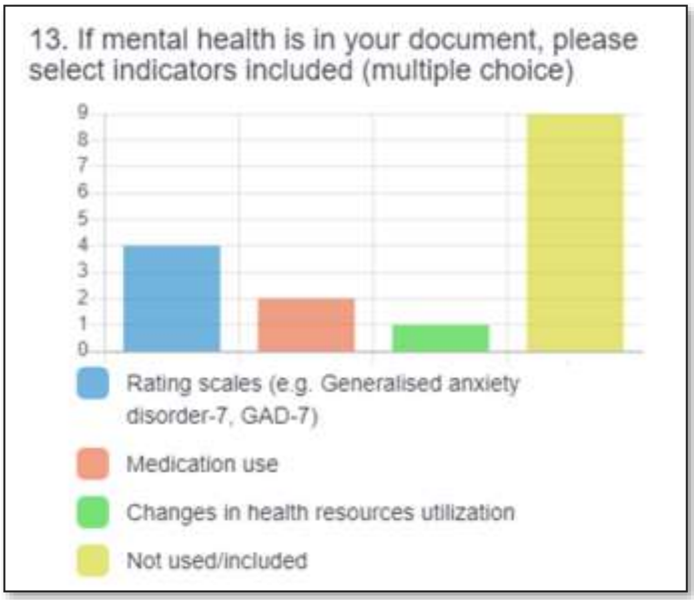

Figure 3. Indicators of mental health retrieved from national policy monitoring documents or decision tools about indirect impact of COVID-19.

Part 2: Medical care disruptions for non-COVID-19 patients

2.a Availability of specialised health care

Disruptions to essential health services have been reported by almost all responding countries in a survey by the World Health Organisation (WHO): they have affected all health care settings and have at least partially persisted one and a half years into the pandemic (72). Cancer care has also been affected, as reports from various countries on decreased rates of cancer diagnoses and changes to cancer treatment show (73–79). A recent scoping review summarises studies that assessed treatment disruptions or modifications for cancer patients during the first pandemic wave (80).

A retrospective observational study carried out in a tertiary cancer centre in Brazil described “changes in the number of radiotherapy sessions for cancer patients” during the first months of 2020 (81). This indicator – as well as other indicators measured in the same study – is used to assess the continuity of oncological treatments during pandemic mitigation measures. The authors compared the periods January to March 2020 (period 1) and April to June 2020 (period 2). The “relative percentage change” was calculated by dividing the average of monthly administered radiotherapy sessions in period 2 by the average in period 1, multiplying the results by 100 and subtracting this result from 100.

$$100 - \left(\frac{\text{COVID 19 sessions}}{\text{PreCOVID 19 sessions}}\right) * 100$$

The data required for calculating this indicator is routinely available from hospital records and there is a simple calculation. The indicator provides an insight into the extent of treatment disruption for cancer patients.

A similar study was conducted in a tertiary cancer centre in France (82). The authors used the same method for calculating the indicator, but compared three different periods with one another (before, during and after containment measures).

Health care indicators were reported in policy monitoring documents or decision tools through the indicator *changes in visits to specialised healthcare (% of change)* (5, 33.3%) or the indicator *changes in the number of radiotherapy sessions for cancer patients* (3, 20.0%). Additionally, the indicator of *waiting lists for admission in residential care* was described (Figure 4).

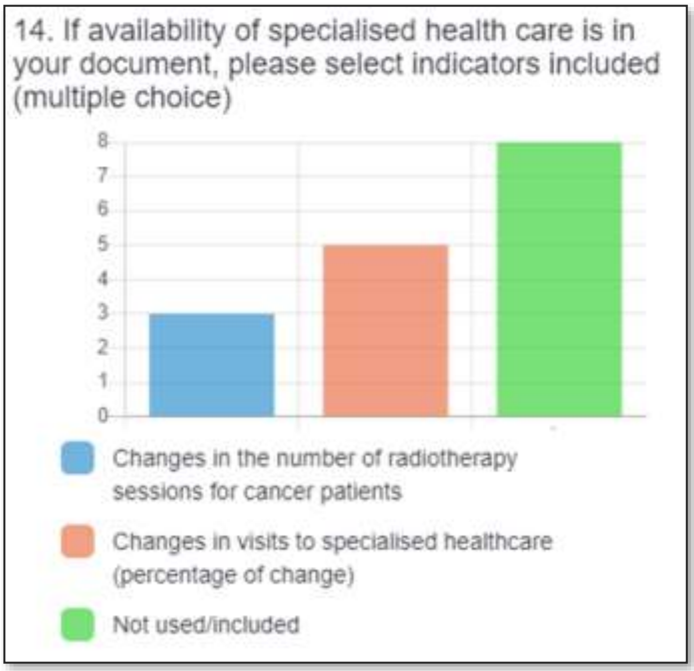

Figure 4. Indicators of availability of specialised healthcare retrieved from national policy monitoring documents or decision tools about indirect impact of COVID-19.

2.b Delayed/cancelled waiting list for scheduled surgeries

Elective surgery was one of the health care services more affected by the pandemic, as ICU beds occupancy was prioritized to critical COVID-19 patients. There was also patients' hesitancy to attend hospitals for elective surgery in that period (83–85).

A retrospective observational study carried out in Italy described the impact of the pandemic and the lockdown measures on hospital activities through indicators of volume and performance in three clinical areas (cardiology, oncology and orthopaedics) (85). For this last one, differences between the "volumes of hip and knee replacement pre-, during and post-pandemic" were computed on a weekly basis for the period January–July 2020 and compared through the paired-sample Wilcoxon test with the average of the corresponding months in 2018–2019 within the three sub-periods mentioned above. The weekly percentage variation of the 2020 value versus the 2018–2019 average was also calculated.

"Percentage of change" was calculated by subtracting the hip and knee replacement surgeries in a specific week of pre-COVID 19 period (pre-lockdown) from the surgeries during a week during the COVID-19 period (during lockdown) and one after COVID-19 lockdown.

$$\left(\text{Number of}\,\frac{\text{hip}}{\text{knee}}\,\text{replacement surgery in week}\,\textbf{pre\_}\text{COVID}\right) - \left(\text{Number of}\,\frac{\text{hip}}{\text{knee}}\,\text{replacement surgery in week}\,\textbf{during}\,\text{COVID(lockdown)}\right)$$

$$\left(\text{Number of}\,\frac{\text{hip}}{\text{knee}}\,\text{replacement surgery in week}\,\textbf{pre\_}\text{COVID}\right) - \left(\text{Number of}\,\frac{\text{hip}}{\text{knee}}\,\text{replacement surgery in week during}\,\textbf{post\_}\text{COVID}\right)$$

The data to calculate the indicator is obtained from the hospital records. The information retrieved from the results of the indicator's calculation is informative of the reduction level in the provided service.

A similar study was conducted at national level in England (UK), using administrative hospital data for 14,930 colorectal cancer patients (CRC) undergoing surgery between October 1, 2019 and May 31, 2020 (84). The authors used the same method for calculating the indicator, but, unlike Spadea et al. analysed the weekly situation, this study set up a threshold date, March 23, 2020 (lockdown start), and analysed the indicator pre and post this date. The results of this study show a 50% reduction in elective CRC procedures pre compared to post lockdown start.

Three policy monitoring documents or decision tools requested in the online survey included the following indicators of delayed/cancelled waiting list for scheduled surgeries: "volume of elective surgery" (20.0%) and one related to "changes in waiting lists" (6.7%).

2.c Primary care visits delay

The pandemic of COVID-19 caused many restrictions and changes in the way that healthcare systems operate on an international level. Primary care was not an exception. For example, in Pakistan, monthly visits to primary care services compared to pre-pandemic state dropped by an average of 12,5% in March and 33% in April of 2020 (86). All-cause visits to primary care clinics decreased by 33% in China as well in February 2020 (87).

A retrospective observational study carried out in Pakistan (86) described differences between “primary care visits” before and during the pandemic. A decrease in “primary care visits” is an indicator that best describes the accessibility of such healthcare provision. The authors calculated the percentage of “change between number of pre-COVID 19 outpatient visits (January and February 2020) and COVID-19 visits (March and April 2020)” for any purpose to the primary care providers. “Percentage of change” was calculated by subtracting the visits in a specific month of pre-COVID 19 period to the visits during the COVID-19 period, divided by the visits in pre-COVID 19 and multiplied by 100.

$$\left(\frac{\text{PreCOVID 19 visits} - \text{COVID 19 visits}}{\text{PreCOVID 19 visits}}\right) * 100$$

A retrospective observational study conducted in China (87) calculated the average of all-cause visits to primary care clinics using the nationwide routine health information system data from January 2016 to June 2020. Data was divided into two groups: pre-COVID-19 data (until February 2020) and data after the emergence of COVID-19 (from February to June 2020).

Percentage of change in visits to primary care can be obtained from primary care service providers. A strength of this indicator is the simplicity of its calculation (a division). The information retrieved from the results of the indicator’s calculation is informative and provides objective and easy-to-understand information about the decline of primary health care.

P*rimary care visits* (3, 20%), *changes in visits to primary care (percentage of change)* (2, 13.3%) or *monthly number of health facility visits pre-COVID vs after COVID-19 pandemic* (1, 6.7%) were indicators used in policy monitoring documents or decision tools.

2.d Reductions in visits and hospitalizations of non-COVID-19 patients with chronic condition

One of the most important effects of the COVID-19 pandemic on the healthcare system is the drastic reduction of face-to-face visits (88) raising concerns about how it will affect the management and control of chronic patients, such as patients with type 2 diabetes mellitus (T2DM). Several studies (89,90) have found a decrease in metabolic control, especially during the lockdown period. T2DM and preventive counselling are usually common reasons to contact primary care practices, but since early March 2020 their frequency of contact has been reduced substantially and their distribution has changed significantly.

During SARS-CoV-2 pandemic, management of chronic non-communicable diseases (NCDs) such as diabetes, hypertension, dyslipidemia could be affected in several ways. Even in the absence of an overload of COVID-19 cases, disease control measures, such as lockdown, quarantine, restrictions of public and private transport or fear of infection might have an impact on accessibility of healthcare (11). This may lead to significant delay or worsening the care, especially when these limitations in access are lasting for a longer time. The management of T2DM occurs almost exclusively in primary care. Therefore, lower general practice attendance due to COVID-19 would likely restrict the ability to perform these essential health checks. Consequently, this could have adverse effects on patient safety and increase the risk of developing long-term diabetes-related complications.

A retrospective cohort study, conducted in 287 primary care practices in Catalonia, Spain (2019-2020) (91), aimed to analyse the relation between face-to-face appointments and management of patients with T2D in primary care practices. *Mean weekly number of face-to-face appointments to physician* was obtained from physicians and nurses dealing with more than 300,000 visits of patients with T2D. *Face-to-face appointments* were computed as sum of visits between September-December for each GP and nurse divided by the number of GPs and nurses and by the number of weeks. The indicator was calculated as the percentage of change between 2019 and 2020.

Similar indicators were used also in a study in Croatia (92) where *number of completed diabetes control panels*, *number of diabetes-related primary healthcare visits* and *number of diabetes-related hospitalisations* and *patients hospitalised for diabetes* were observed across years 2017 – 2020.

The results of both studies show that reducing face-to-face visits negatively impacted T2D patients' follow-up. The limitation of the "face to face appointments" indicator is mainly its interpretation, because part of the face-to-face visits may be replaced by teleconsultations.

In a retrospective cohort study carried out in Switzerland, T2DM patients (≥ 18 years) with at least one consultation at a general practitioner were followed up for two years, during two periods (2018-2019 for cohort 1 and 2019-2020 for cohort 2) (93). Quality indicators and outcomes of diabetes care, at patient and practitioner level, were compared before and during the pandemic. *Reduction in follow-up visits in T2DM patients* is one of the indicators used to measure the impact of pandemics on reducing care for T2DM in terms of the frequency and quality of care provided to patients with diabetes. Indicators of diabetes care quality were denominated as proportions of patients with several T2DM outcomes in a year interval. Carr et al. included also urinary albumin excretion and compared observed versus expected proportion of patients with measurement (94). However, alternatives to face-to-face consultations might have been introduced in order to minimise the impact of COVID-19 pandemic on quality of care, which are not considered in the study. The authors found a considerable quality reduction in T2DM during the pandemic compared to the previous year.

The indicators of reductions in visits and hospitalizations of non-COVID-19 patients with chronic conditions most used in the selected policy monitoring documents or decision tools were *changes in visits to hospital of patients with chronic condition (percentage of change)*, *number of chronic diseases-related healthcare visits (cardiovascular, diabetes, rheumatic disease, etc.)* and *number of chronic diseases-related hospitalisations* (4, 26.7%, respectively) (Figure 5).

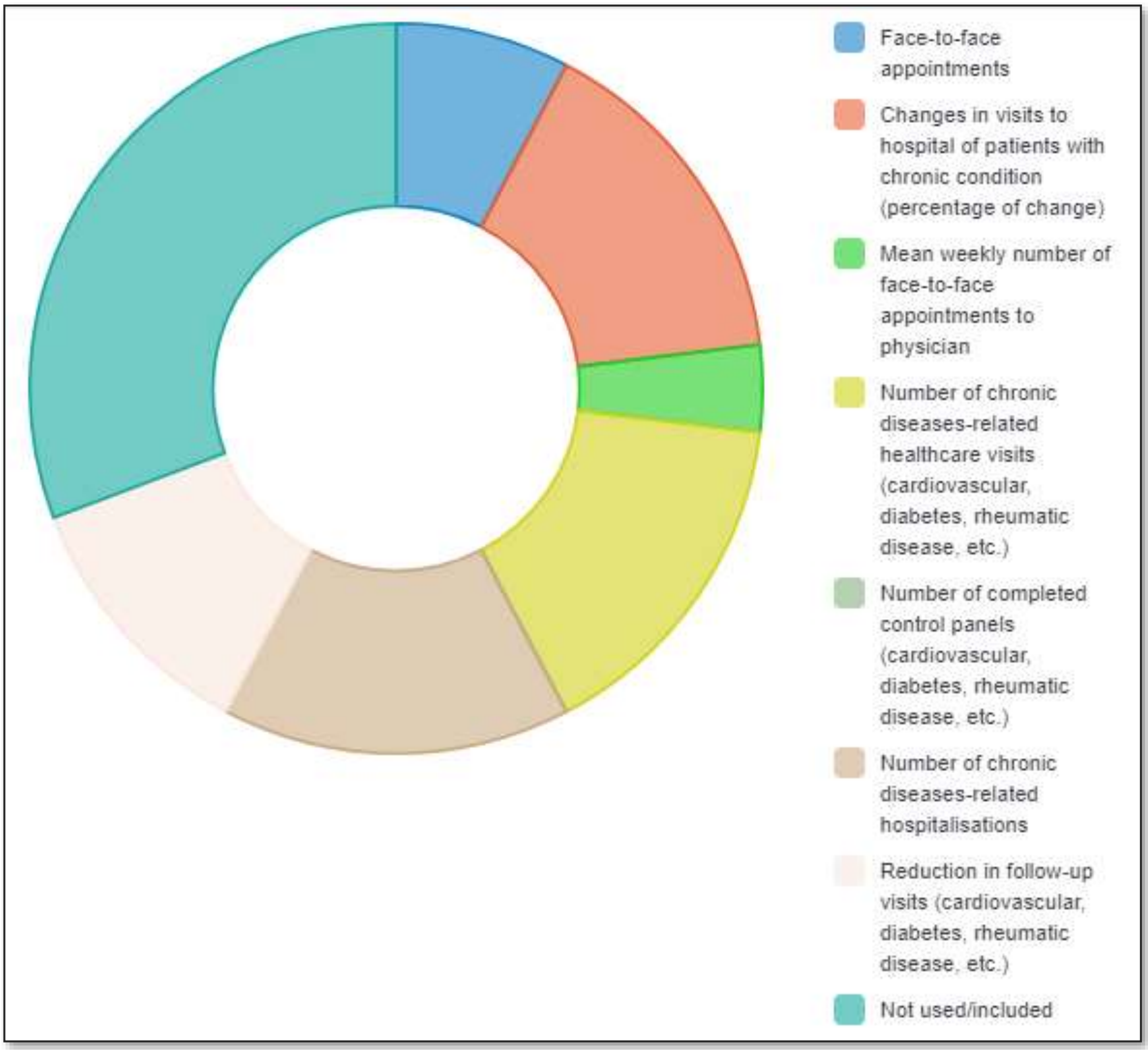

Figure 5. Indicators of reductions in visits and hospitalizations of non-COVID-19 patients with chronic condition retrieved from national policy monitoring documents or decision tools about indirect impact of COVID-19.

2.e Perinatal screening

New born screening (NBS) programmes are public health programmes for detecting certain serious congenital diseases in babies to treat them before the onset of symptoms. COVID-19 has affected the diagnosis and management of patients with inborn errors of metabolism included in NBS programmes (95,96).

A retrospective observational study carried out in Turkey (97) measured the “changes in visits to a perinatal department” that occurred before and during the first year of the COVID-19 pandemic. The indicator describes the reduction of visits to a perinatal department in order to develop strategies to maintain the usual levels of prenatal care during the impact of a pandemic. The authors calculated the *percentage of change between number of pre-COVID-19 outpatients visits (from 11 March 2019 and 10 March 2020) and COVID-19 visits (11 March 2020 and 10 March 2021) to their perinatology department*. Percentage of change was calculated by subtracting the visits in a specific month of pre-COVID 19 period to the visits during the COVID-19 period. This difference was divided by the visits in pre-COVID 19 and multiplied by 100.

$$\left(\frac{\text{PreCOVID 19 visits} - \text{COVID 19 visits}}{\text{PreCOVID 19 visits}}\right) * 100$$

The data to calculate the indicator is easy to obtain in a hospital setting. The calculation of the indicator is a simple division. The information retrieved from the results of the indicator’s calculation is informative of the reduction level in the provided service.

Koracin et al. conducted an international survey between February and March 2021 to explore the impact of the pandemic on the execution of NBS services (first and second waves) (98). Responses were obtained from 44 different screening centres from 38 countries. The second part of the questionnaire asked about any impairment in the NBS programmes experienced due to the pandemic, including obstacles to the conduct of testing, confirmatory diagnostics, communication with the parents, possible missed cases, consequent metabolic crises and existing plans/ guidelines for screening in the event of pandemics and serious disruption to health. They measured the *impairment of new born screening* during the pandemic as an overall indicator using a 5-point Likert scale (from 1, none, to 5, a great deal). In addition, for the study assessed the degree of impact of the COVID-19 pandemic on main aspects of NBS programmes like: *delays in providing laboratory equipment*, *diagnostic delays* or *informing parents borderline/positive results*. The indicators expressed the percentage of answers (%) among five options (from a great deal to not at all) .The authors also used a scale for measuring the impact of the pandemic on *parents being reluctant to come for retesting/further testing*, *substituting face-to-face visits with telemedicine* and *referral of positive children/parents to further diagnostics*. The calculation of the indicators was a as the percentage of respondents among all the surveys completed (n=44).

Another study carried out also an online survey with the aim to assess the *use of telemedicine in the referral process for NBS* during the initial months of the COVID-19 pandemic (March-June 2020)(99). They analysed the change in practice before and after the pandemic. The indicators used for measuring the impact of the pandemic were: *telemedicine use for NBS triage (%)*, *parental refusal to present to the emergency department (ED) for NBS follow-up (%)* and *NBS visit staff (%)* (physician, physician extender, nurse, genetic counsellor, dietitian, social worker and trainee).

Greaves et al. (96) determined if there was a significant change in the NBS service delivery as a consequence of the COVID-19 associated restrictions, using three key performance indicators (KPIs) routinely reported to the Victorian Department of Health and Human Services. These quantitative indicators were examined for each of the four full months from April to July 2020 and were compared with the same period in the previous two years (2018 and 2019).

- *Timeliness of sample collection*: percentage of dried bloodspot (DBS) sample cards collected within the agreed standard timeframe, with the denominator being the total number of first sample newborn screening cards received by the laboratory.

  $$\left(\frac{\text{DBS cards collected within the agreeed standard timefame}}{\text{total number of first sample newborn screening cards received}}\right) * 100$$

  The benchmark for the performance of this indicator is that 95% of babies born in Victoria should have a sample collected before 72 hours of age.
- *Timeliness of sample transport*: percentage of DBS cards received in the laboratory within the agreed standard timeframe, with the denominator being the total number of first sample newborn screening cards received by the laboratory.

  $$\left(\frac{\text{DBS cards received in the laboratory within the agreeed standard timefame}}{\text{total number of first sample newborn screening cards received}}\right) * 100$$

  The benchmark for the performance of this indicator is that 95% of samples should be in transit for less than 96 hours.
- *Timeliness of screening and reporting of results to all hospitals/pro*viders: percentage of newborn bloodspot results reported to the maternity provider within the agreed standard timeframe, with the denominator being the total number of first sample newborn screening cards received by the laboratory.

  $$\left(\frac{\text{newborn bloodspot results reported to the maternity provider}}{\text{total number of first sample newborn screening cards received}}\right) * 100$$

The benchmark for the performance of this indicator is that 95% of babies born in Victoria should have an NBS result by 9 days of age. The screening results were cumulated to determine the calculations for the key performance indicators related to turnaround time.

Only one policy monitoring document reported the use of one perinatal screening indicator, related to *changes in visits to a perinatal department (percentage of change*).

2.f Cancer screening

In numerous health systems, cancer screening programs were among the first activities interrupted by the COVID-19 pandemic after its irruption in early 2020. As reported in a survey by the International Cancer Screening Network, 97% of participating settings reported that COVID-19 had adversely impacted their screening programs, while 90% partially suspended their activity (100,101). Even in countries with notable success in containing the pandemic, like Taiwan, the population attending cancer screening visits decreased during the first half of 2020 (102).

In a before-and-after study carried out in Spain (103), the effect of the COVID-19 pandemic on performance indicators in the population-based breast cancer screening program of Barcelona MAR Health Park was assessed. The *screening participation rate* was measured as the percentage of women invited for screening who underwent mammography in the corresponding round. Since some women could still have participated after the end of data collection, there could be a small bias overestimating the reduction in participation. The long period of four previous rounds (8 years) of invitations for the same target population is a strength of the study. Fluctuations in participation and cancer detection may depend on time. The approach provides information on the pandemic beyond these common fluctuations.

A similar study was conducted in colorectal cancer, one of the most prevalent malignancies in the Asia-Pacific region (104). The *screening participation rate*, number of FITs (fecal immunochemical test) done, measured among those with positive FITs in 2019 and 2020. The results of 2020 were compared with those of 2019.

$$Screening\ participation\ rate\ = \left(\frac{The\ number\ of\ FIT\ kits\ returned}{The\ FIT\ \ kits\ delivered}\right)$$

The above indicator was calculated as appropriate and when feasible. For example, in countries where FIT kits were sent via postal mail (Australia or New Zealand), the screening participation rate was calculated. In countries where people need to visit clinics or hospitals to obtain FIT kits (such as Taiwan, Japan, Korea, and Hong Kong), it was not feasible to calculate the real participation rate.

Also the *recall rate* was estimated as the percentage of participants who were advised to undergo further assessment to rule out malignancy, whether non-invasive or invasive (ultrasound, tomosynthesis, contrast-enhanced mammography, biopsy, and/or others)(103). Additional models, including only participants, were created to assess the impact of COVID-19 on the other main indicators of the screening program: recall and false positives. Despite the lower participation, the remaining performance indicators in the program did not seem to be negatively affected by the pandemic. Their results showed a statistically significant reduction in the recall rates of both prevalent and incident screening. The *false positives* were estimated based on the percentage of women who underwent additional non-invasive or invasive assessments but who did not have a diagnosis of cancer after completion of additional examinations.

A systematic review of studies conducted before the pandemic reported lower participation in low-income groups, immigrants, non-homeowners, and women with a previous false-positive result (105). The *compliance with recall* was analysed only among patients advised to undergo further assessment, the percentage of these patients who agreed to take additional tests in the facilities. For *compliance with recall*, the study used a logistic regression model to obtain crude odds ratios since it did not adjust for any variables due to the reduced sample size (103).

Finally, the *detection rate* was the number of breast cancers detected at screening per 1000 participants. The study calculated this rate, stratifying by type of breast cancer histology (i.e., the invasive or in situ cancer detection rate). A similar study was conducted in a Brazilian metropolitan area (106). Cancer detection rate is defined as TP (true-positive mammography) tests divided by a total of screening mammograms (TP/total).

Another study estimated the short-term impact of the temporary shutdown (from March until May-June) of the cancer screening programs invitations in Flanders (Belgium)(107). To analyse the short-term impact of COVID-19 and the shutdown of invitations of the three cancer screening programs throughout 2020, the *yearly invitation coverage* was calculated as the number of people who received an invitation, as a proportion of the people who should have received an invitation that year. The key program indicators are calculated on patient-level data and measurement bias on data from the screening database is considered to be extremely low thanks to an important number of automated inconsistency checks that are performed when the data are entered. In addition, "weekly response to the invitation" was calculated as the number of people who were screened within 40 days of their date of invitation, as a percentage of the people who received an invitation that week (as a proxy for willingness to screen). *Weekly screening interval* was calculated as the mean number of months between the current screening and the previous screening of all the people who screened that week. The two last indicators (percentage of people screened within 40 days after invitation & screening interval) were calculated for each week in 2019 and 2020, after which the difference between that week's value in 2020 and 2019 with 95% confidence intervals. Results of these two indicators were also analysed after stratification by gender, age and participation history.

The indicators identified in the selected policy monitoring documents related to cancer screening were *screening participation rate* (3, 20.0%), and *detection rate*, *yearly invitation coverage (proportion of the people who should have received an invitation)* or *weekly screening interval (months between current screening and previous screening* (1, 6.7%, respectively).

2.g Screening of non-COVID-19 infectious diseases

During COVID-19 pandemic movement restrictions and other lockdown measures have affected transmission of communicable diseases, mainly viral respiratory infections other than COVID-19 (108). However, limitations enforced with lockdowns also gave rise to risky behaviours associated with transmission of a different set of communicable diseases such as hepatitis B and C (109). In addition, the disruption of health care services during the pandemic significantly reduced access to screening, clinical care and treatment possibly causing longer-term impact on disease burden of hepatitis viruses and putting the WHO's hepatitis B and C virus elimination targets at risk of failure (110).

A retrospective observational study was carried out in Madrid, Spain (111) to determine the impact on hepatitis C virus (HCV) screening and describe the *change in the number of HCV tests conducted during COVID-19 compared to the pre-COVID-19 period*. The information obtained from this study was important to monitor HCV elimination strategies and to inform revision, development, and implementation of actions to restore HCV testing and treatment to pre-pandemic levels.

The authors calculated a set of indicators to assess the impact of the pandemic on surveillance of HPV, HCV and HIV. The indicators were calculated for different waves of the pandemic, each time comparing months during the pandemic with corresponding months in the pre-pandemic period. Percentage of change was calculated by subtracting the number of hepatitis C virus tests during the COVID-19 period from the number of hepatitis C virus tests in the pre-COVID-19 period. This was divided by the number of tests during the pre-COVID-19 period and multiplied by 100.

$$\left(\frac{\text{preCOVID 19 HCV tests} - \text{COVID 19 HCV tests}}{\text{preCOVID 19 HCV tests}}\right) * 100$$

The information retrieved from the results of the indicator's calculation is informative of the reduction in the provided service. The data is easy to obtain from laboratory records, however population coverage of the data depends on the source of information – area of the laboratory that reports number of tests analysed and/or existence of registry data on screening for HCV. Other authors reported the percentage of change comparing number of hepatitis C virus tests between periods which varied time intervals between studies and applied techniques to remove duplicates or repeated laboratory tests (112–114). Mandel et al. conducted a study to examine the *changes in HCV testing volume from January 2019 to May 2021*. The changes were presented in both absolute values per month and as percentages using the indicator calculation method presented above. The data was categorized into pandemic waves, although it is noted that the time periods used to define the waves varied between Mandel et al. and Romero-Hernández et al. In contrast, Kaufman et al. focused on the changes in HCV testing volume from January to July 2020 compared to the same time periods in 2018 and 2019. The same calculation method was used as in Romero-Hernández et al., however, the results were presented per individual month instead of pandemic waves. Furthermore, Morales-Arráez et al. (2022) (114) compared the indicator values over a 10-month period before and during the pandemic, with the pivot point being March 15th. The study also presented the changes in HCV testing volume based on the origin of the test request, such as primary healthcare or drug treatment centres. Any differences in screening protocols are not acknowledged in the indicator, which is important to account for in comparing indicator values between studies from different areas.

The indicators identified in the selected policy monitoring documents related to screening of non-COVID-19 infectious diseases matching with the narrative review were *difference of HCV analysed samples between pandemic waves*, and *testing volume (e.g. HCV, HIV, HPV*) (1, 6.7%, respectively). A questionnaire added the indicator gathering *rates of influenza A, influenza B, respiratory syncytial virus (RSV)-infection, rhinovirus, adenovirus, parainfluenza, and human metapneumovirus (HMPV) infection*.

D. Discussion

Impact of COVID-19 on global health conditions or health status was measured by indicators as DALYs, “health related quality of life”, cost of illness, life expectancy at birth or at 65 years old. Such indicators implemented in the scientific literature were also found in European policy documents and decision tools. Some indicators (i.e.: HRQoL and mental health) were determined through scales obtained from questionnaires (48,51,52,68,115). One policy document also included *mental health measured by the General Health Questionnaire (12 item scale; GHQ-12)*(116).

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 vast majority of them. However, rating scales are easy to apply in a wide range of circumstances and settings with no additional resources or expenses required, and they cover numerous aspects of health status. These characteristics have promoted their use as indicators during the pandemic to compare with previous years in research studies.

The repercussion of the epidemic turned out in reductions in life expectancy between 2020 and 2021 (117). However, the real age-specific mortality rates of any exact birth cohort cannot be known previously. Because the pandemic impact in terms of deaths is diminishing, true life spans will mainly be, greater than life expectancy estimated using average mortality estimated in 2020. The studies included in this review show an interest to describe the different impact of COVID-19 in life expectancy as well as in life of span to highlight inequalities (30,31,34). Therefore, it is important to stratify by socioeconomic status, educative level or ethnicity to guide national policies against future health crises. Harmonising these contextual variables is crucial to achieve improved surveillance systems. Additionally, in the reviewed studies, life expectancy was calculated for all-causes of death, thus the indicator describes indirect and direct impact of COVID-19. Studies identifying specific causes of death could help to discriminate direct from indirect impact. However, in a first wave of a pandemic overwhelming health systems such studies could not be feasible. Excess of mortality indicator will still play a relevant role for future health crises if there is not an improvement classifying death causes.

Results using indicators of indirect impact of COVID-19 suggested that access to health services, and their use and functioning were disrupted due to the COVID-19 epidemic. Quality/performance indicators have been used in medicine to measure quality of care and assess operational conditions and trends of practice over time, as well as plans of action for a continuous quality improvement (118). The studies retrieved in this review included examples of “changes in the number of radiotherapy sessions”, “changes in visits to a perinatal department”, “timeless of sample collection”, "monthly number of health facility visits", etc. The most frequent indicator present in policy document and decision tools was *changes in visits to specialised healthcare (% of change)*.

Most of the indicators were calculated comparing previous dates of pandemic vs months during the pandemic or even among waves. In general, the data required for building and calculating these indicators were easy to obtain from hospital setting (85,97), from primary care service providers (87) or laboratory records (111), among others.

Indicators were based on absolute mathematical measurements (e.g. life expectancy, numbers of admissions/surgeries pre-post versus during pandemic, mean weekly number of face-to-face appointments to physicians…) or relative measurements (percentage of change, e.g. comparing screening participation rates or cancer detention rates).

E. Conclusions and implications for public health

The present review offers a rapid vision on the indirect impact provoked by the COVID-19 crisis. This pandemic has had an important effect on health status and health systems management. We present a comprehensive and summarised overview of the health indicators found in a vast research on the potential and established indirect impacts of the COVID-19 pandemic focusing on health status and wellbeing as well as collateral damage to medical care of COVID and non-COVID-19 patients.

Though this pandemic appears to be subsiding, the knowledge of main indicators involved in the evaluation of health status and medical care will allow us to provide quality and safe care for our patients with minimal interruption of services and to prepare the healthcare systems to future health crisis. These indicators might be considered in the context of health inequalities not only in the research but also in policy documents. Timely detection of inequities will help to mitigate the impact of applying social distancing measures. Costs studies could also help to evaluate the net benefit of diverting material and human resources from usual practice to exceptional demands caused by health crisis.

Lessons learned during this pandemic have emphasized the need to prepare for resilient health systems with the capacity to adapt to challenges and changes at different system levels, to maintain medical consultation of primary and specialised care, programmed surgeries or screening tests supporting and reinforcing the available human and material resources, as pointed out by the European commission (EC). The EC has undertaken an analysis of the healthcare in Europe to show the impact of the "Recovery and Resilience Facility" funding as a part of the NextGenerationEU recovery plan[119].

The indicators collated here could already comprise useful tools to assess the impact of future pandemics. Therefore, it is crucial to harmonise their calculation in order to facilitate comparisons at different points in time and among different populations between settings and countries.

During the present and future pandemics, it is important to have a harmonised set of indicators on hand, disseminated on policy documents and decision tools and classified by main affected areas, that could help public health institutions to monitor disease elimination strategies, to perform early prevention measures, to maintain robust health systems with the broad aim maintaining the population's physical and mental health.

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G. Suplementary material

1. S1. Pubmed search strategy

Burden of disease

(("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "COVID-19 serotherapy"[Supplementary Concept] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR ("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields])) AND ("impact*"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields]) AND ("indicator*"[All Fields] OR "health status indicator*"[All Fields] OR "Health Status Indicators"[MeSH Terms] OR "Health Status"[MeSH Terms]) AND ("Global Burden of Disease"[All Fields] OR "Global Disease Burden"[All Fields] OR "disease burden global"[All Fields] OR "Global Disease Burdens"[All Fields]) AND 2021/01/01:2022/11/30[Date - Publication]) AND (2021:2022/11[pdat])

Life expectancy

("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR "coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields]) AND "(Global Burden of Disease"[Title/Abstract] OR "Global Disease Burden"[Title/Abstract] OR "disease burden global"[Title/Abstract] OR "Global Disease Burdens"[All Fields] OR "dalys"[All Fields])

Quality of life

(("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "COVID-19 serotherapy"[MeSH Terms] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR ("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields])) AND ("impact*"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields]) AND ("indicator*"[All Fields] OR "health status indicator*"[All Fields] OR "Health Status Indicators"[MeSH Terms] OR "Health Status"[MeSH Terms]) AND ("quality of life"[All Fields] OR "Life Quality"[All Fields] OR "health related quality of life"[All Fields] OR "health related quality of life"[All Fields] OR "HRQOL"[All Fields])) AND (2021:2022/11[pdat])

Cost of illness

(("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "COVID-19 serotherapy"[Supplementary Concept] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR ("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields])) AND ("impact*"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields]) AND ("indicator*"[All Fields] OR "health status indicator*"[All Fields] OR "Health Status Indicators"[MeSH Terms] OR "Health Status"[MeSH Terms]) AND ("Illness Cost"[All Fields] OR "Illness Costs"[All Fields] OR "Cost of Sickness"[All Fields] OR "Sickness Costs"[All Fields] OR "Sickness Cost"[All Fields] OR "Burden of Illness"[All Fields] OR "Illness Burden"[All Fields] OR "Illness Burdens"[All Fields] OR "Disease Burden"[All Fields] OR "burden disease"[All Fields] OR "Disease Burdens"[All Fields] OR "Costs of Disease"[All Fields] OR "Disease Cost"[All Fields] OR "cost disease"[All Fields] OR "Disease Costs"[All Fields] OR "Economic Burden of Disease"[All Fields] OR "Burden Of Disease"[All Fields] OR "Burden Of Diseases"[All Fields] OR "Cost of Disease"[All Fields])) AND (2021:2022/11[pdat])

Mental health status

(("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "COVID-19 serotherapy"[Supplementary Concept] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR ("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields])) AND ("impact*"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields]) AND ("indicator*"[All Fields] OR "health status indicator*"[All Fields] OR "Health Status Indicators"[MeSH Terms] OR "Health Status"[MeSH Terms]) AND ("status health"[All Fields] OR "Level of Health"[All Fields] OR "Health Level"[All Fields] OR "Health Levels"[All Fields] OR "Self-Perceived"[All Fields] OR "Self-report"[All Fields] OR "patient-reported"[All Fields]) AND 2021/01/01:2022/11/30[Date - Publication])

Availability of specialised health care

("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "COVID-19 serotherapy"[Supplementary Concept] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR "coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields]) AND ("impact*"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields]) AND ("indicator*"[All Fields] OR "health status indicator"[All Fields] OR "Health Status Indicators"[MeSH Terms] OR "Health Status"[MeSH Terms]) AND ("Health Services"[MeSH Terms] OR "Delivery of Health Care"[MeSH Terms]) AND 2021/01/01:2022/11/30[Date - Publication]

Delayed/cancelled waiting list for scheduled surgeries

(("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "COVID-19 serotherapy"[Supplementary Concept] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH

Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR "coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields]) AND ("impact*"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields]) AND ("indicator*"[All Fields] OR "health status indicator"[All Fields] OR "Health Status Indicators"[MeSH Terms] OR "Health Status"[MeSH Terms]) AND ("surgery"[MeSH Subheading] OR "surgery"[All Fields] OR "surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical procedures"[All Fields] OR "general surgery"[MeSH Terms] OR ("general"[All Fields] AND "surgery"[All Fields]) OR "general surgery"[All Fields] OR "surgery s"[All Fields] OR "surgerys"[All Fields] OR "surgeries"[All Fields] OR "surgical procedures"[All Fields] OR "operation theatre"[All Fields]) AND ("reduction*"[All Fields] OR "decrease*"[All Fields] OR "decline*"[All Fields] OR "change*"[All Fields] OR "delay*"[All Fields] OR "cancel*"[All Fields] OR "diminish*"[All Fields])) AND (2021:2022/11[pdat])

Primary care visits delay

("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "COVID-19 serotherapy"[Supplementary Concept] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR "coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields]) AND ("impact*"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields]) AND ("indicator*"[All Fields] OR "health status indicator"[All Fields] OR "Health Status Indicators"[MeSH Terms] OR "Health Status"[MeSH Terms]) AND ("primary care"[All Fields] OR "primary health care"[All Fields]) AND ("reduction*"[All Fields] OR "decrease*"[All Fields] OR "decline*"[All Fields] OR "change*"[All Fields] OR "delay*"[All Fields] OR "cancel*"[All Fields] OR "diminish*"[All Fields]) AND ("visit*"[All Fields] OR "attend*"[All Fields] OR "utilization*"[All Fields]) AND 2021/01/01:2022/11/30[Date - Publication]

Reductions in visits and hospitalizations of non-COVID-19 patients with chronic condition

(("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "COVID-19 serotherapy"[Supplementary Concept] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR "coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields]) AND ("impact*"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields]) AND ("indicator*"[All Fields] OR "health status indicator"[All Fields] OR "Health Status Indicators"[MeSH Terms] OR "Health Status"[MeSH Terms]) AND (("Chronic disease"[All Fields] OR "noncommunicable diseases"[All Fields] OR "Non-COVID Diseases"[All Fields] OR "cancer*"[All Fields] OR ("diabete"[All Fields] OR "diabetes mellitus"[MeSH Terms] OR ("diabetes"[All Fields] AND "mellitus"[All Fields]) OR "diabetes mellitus"[All Fields] OR "diabetes"[All Fields] OR "diabetes insipidus"[MeSH Terms] OR ("diabetes"[All Fields] AND "insipidus"[All Fields]) OR "diabetes insipidus"[All Fields] OR "diabetic"[All Fields] OR "diabetics"[All Fields] OR "diabets"[All Fields]) OR "osteoporosis"[All Fields] OR ("osteoarthritis"[MeSH Terms] OR "osteoarthritis"[All Fields] OR "osteoarthritides"[All Fields]) OR ("obeses"[All Fields] OR "obesity"[MeSH Terms] OR "obesity"[All Fields] OR "obese"[All Fields] OR "obesities"[All Fields] OR "obesity s"[All Fields])) AND 2021/01/01:2022/11/30[Date - Publication]) AND 2021/01/01:2022/11/30[Date - Publication] AND (("primary health care"[MeSH Terms] OR ("primary"[All Fields] AND "health"[All Fields] AND "care"[All Fields]) OR "primary health care"[All Fields] OR ("primary"[All Fields] AND "care"[All Fields]) OR "primary care"[All Fields]) AND ("consultancies"[All Fields] OR "consultancy"[All Fields] OR "consultant s"[All Fields] OR "consultants"[MeSH Terms] OR "consultants"[All Fields] OR "consultant"[All Fields] OR "consultative"[All Fields] OR "consulter"[All Fields] OR "consulters"[All Fields] OR "referral and consultation"[MeSH Terms] OR ("referral"[All Fields] AND "consultation"[All Fields]) OR "referral and consultation"[All Fields] OR "consult"[All Fields] OR "consultation"[All Fields] OR "consultations"[All Fields] OR "consulted"[All Fields] OR "consulting"[All Fields] OR "consults"[All Fields]))) AND (2021:2022/11[pdat])

Perinatal screening

(("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "COVID-19 serotherapy"[Supplementary Concept] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR "coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields]) AND ("impact*"[All

Fields] OR "impactful"[All Fields] OR "impacting"[All Fields]) AND (("Neonatal screening"[All Fields] OR "prenatal diagnosis"[All Fields] OR "Noninvasive prenatal testing"[All Fields] OR "Perinatal screening"[All Fields]) AND 2021/01/01:2022/11/30[Date - Publication])) AND (2021:2022/11[pdat])

Cancer screening

(("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "COVID-19 serotherapy"[Supplementary Concept] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR "coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields]) AND ("impact*"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields]) AND ("indicator*"[All Fields] OR "health status indicator"[All Fields] OR "Health Status Indicators"[MeSH Terms] OR "Health Status"[MeSH Terms]) AND (("mass screening"[All Fields] OR "cancer screening"[All Fields]) AND 2021/01/01:2022/11/30[Date - Publication])) AND (2021:2022/11[pdat])

Non-Covid infectious diseases screening

(("COVID-19"[All Fields] OR "COVID-19"[MeSH Terms] OR "COVID-19 Vaccines"[All Fields] OR "COVID-19 Vaccines"[MeSH Terms] OR "COVID-19 serotherapy"[All Fields] OR "COVID-19 serotherapy"[Supplementary Concept] OR "covid 19 nucleic acid testing"[All Fields] OR "covid 19 nucleic acid testing"[MeSH Terms] OR "covid 19 serological testing"[All Fields] OR "covid 19 serological testing"[MeSH Terms] OR "covid 19 testing"[All Fields] OR "covid 19 testing"[MeSH Terms] OR "sars cov 2"[All Fields] OR "sars cov 2"[MeSH Terms] OR "Severe Acute Respiratory Syndrome Coronavirus 2"[All Fields] OR "NCOV"[All Fields] OR "2019 NCOV"[All Fields] OR "coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "COV"[All Fields]) AND ("impact*"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields]) AND ("hepatitis C"[All Fields] AND "virus"[All Fields]) AND 2021/01/01:2022/11/30[Date - Publication] AND 2021/01/01:2022/11/30[Date - Publication] AND 2021/01/01:2022/11/30[Date - Publication] AND ("diagnosis"[MeSH Subheading] OR "diagnosis"[All Fields] OR "screening"[All Fields] OR "mass screening"[MeSH Terms] OR ("mass"[All Fields] AND "screening"[All Fields]) OR "mass screening"[All Fields] OR "early detection of cancer"[MeSH Terms] OR ("early"[All Fields] AND "detection"[All Fields] AND "cancer"[All Fields]) OR "early detection of cancer"[All Fields] OR "screen"[All Fields] OR "screenings"[All Fields] OR "screened"[All Fields] OR "screens"[All Fields])) AND (2021:2022/11[pdat])

2. Characteristics of the studies and indicators extracted in the narrative review

See excel file

3. Survey on policy documents and decision tools

Indicators of indirect impact caused by COVID-19 used in policy monitoring or decision tools of promotion, prevention and care of COVID-19 patients

We are inviting you again to participate in a survey aiming at identifying the main health indicators used to measure the **indirect impact** of COVID-19 through information gathered in **policy monitoring documents** or **decision tools** available in your country. The selected document could be written in English or your own language. Documents on policy monitoring or decision tools might be referred as 'action plan', 'traffic light', 'algorithm', 'score', 'degrees', 'strategy', 'monitoring', 'tool' or 'evaluation', among others.

Please, find below the following documents as an example:

COVID-19 Health Inequalities Monitoring for England

https://analytics.phe.gov.uk/apps/chime/ (see life expectancy indicator)

Wider Impacts of COVID-19 on Health (WICH) monitoring tool

https://analytics.phe.gov.uk/apps/covid-19-indirect-effects/

Please, **complete one survey per each document** you have selected. We really appreciate if you could complete at least the information required from one policy document and/or decision tool on any of the following topics: 1) Burden of disease, 2) Life expectancy 3) Quality of life, 4) Cost of illness, 5) Mental health, 6) Availability of specialised health care, 7) Delayed/cancelled waiting list for scheduled surgeries, 8) Primary care visits delay, 9) Reductions in visits and hospitalizations of non-COVID-19 patients with chronic condition, 10) Perinatal screening, 11) Cancer screening, 12) Screening of non-COVID-19 infectious diseases.

This survey aims at identifying *the health indicators most used* to evaluate the **indirect impact** of COVID-19 pandemic on health **promotion**, **prevention** and **care**.

The indirect impact refers to the effects of the COVID-19 on other conditions and health services. E.g. one of the critical indirect impacts of the pandemic has been severe disruptions to the delivery and use of routine services, including essential health services.

Questions (Q) and Replies (R)

[Q]: Please, provide your institutional email

[R]: [Text file with @] [Mandatory]

Q: Please, provide your name and surname

R: [Text file] [Mandatory]

Q: Respondent's country

R: [Mandatory]

Q: Document title

R: [Free text file]

Q: Link to the document

R: [Free text file]

Q: Which is the aim of the document (policy monitoring or decision tool document)?

The goal is to collect a set of health indicators used to evaluate the indirect impact of COVID-19 on health **promotion**, **prevention** and **care** (multiple choice)

R: Promotion

Prevention

Care of COVID-19 patients

Q: Is your document a dashboard?

R: Yes

No

Q: Is your document a weekly report?

R: Yes

No

Q: If **burden of disease** is in your document, please select indicators included (multiple choice)

R: DALYs (disability-adjusted life years)

YLLs (Years of life lost from mortality)

YLDs (Years of healthy life lost due to disability)

Other indicator [Free text file]

Not used/included

Q: If **life expectancy** is in your document, please select indicators included (multiple choice)

R: Life expectancy at birth

Life expectancy at 65 years old

Other indicator [Free text file]

Not used/included

Q: If **quality of life** is in your document, please select indicators included (multiple choice)

R: SF-36 (Medical Outcomes Study Short Form 36-item health survey)

EQ-5D

KIDSCREEN-10 index

Other indicator [Free text file]

Not used/included

Q: If **cost of illness** is in your document, please select indicators included (multiple choice)

R: Productivity losses

Lost productivity cost due to absenteeism

Rate of absenteeism per year

Total cost of absenteeism per year

Other indicator [Free text file]

Not used/included

Q: If **mental health** is in your document, please select indicators included (multiple choice)

R: Rating scales (e.g. Generalised anxiety disorder-7, GAD-7)

Medication use

Changes in health resources utilization

Other indicator [Free text file]

Not used/included

Q. If **availability of specialised health care** is in your document, please select indicators included (multiple choice)

R: Changes in the number of radiotherapy sessions for cancer patients

Changes in visits to specialised healthcare (percentage of change)

Other indicator [Free text file]

Not used/included

Q. If **delayed/cancelled waiting list for scheduled surgeries** is in your document, please select indicators included (multiple choice)

R: Volume of elective surgery

Changes in waiting lists healthcare (percentage of change)

Other indicator [Free text file]

Not used/included

Q. If **primary care** visits delay is in your document, please select indicators included (multiple choice)

R: Primary care visits

Changes in visits to primary care (percentage of change)

Monthly number of health facility visits pre-COVID vs after COVID-19 pandemic

Other indicator [Free text file]

Not used/included

Q. If **reductions in visits and hospitalizations of non-COVID-19 patients with chronic condition** is in your document, please select indicators included (multiple choice)

R: Face-to-face appointments

Changes in visits to hospital of patients with chronic condition (percentage of change)

Mean weekly number of face-to-face appointments to physician

Number of chronic diseases-related healthcare visits (cardiovascular, diabetes, rheumatic disease, etc.)

Number of completed control panels (cardiovascular, diabetes, rheumatic disease, etc.)

Number of chronic diseases-related hospitalisations

Reduction in follow-up visits (cardiovascular, diabetes, rheumatic disease, etc.)

Other indicator [Free text file]

Not used/included

Q. If **perinatal screening** is in your document, please select indicators included (multiple choice)

R: Changes in visits to a perinatal department (percentage of change)

Impairment of new born screening

Delays in providing laboratory equipment

Diagnostic delays

Informing parents borderline/positive results

Parents being reluctant to come for retesting/further testing

Substituting face-to-face visits with telemedicine

Referral of positive children/parents to further diagnostics

New Born Screening (NBS) visit staff (%) (physician, physician extender, nurse, genetic counsellor, dietitian, social worker and trainee)

Telemedicine use for NBS triage (%)

Timeliness of sample collection

Timeliness of sample transport

Timeliness of screening and reporting of results to all hospitals/providers

Other indicator [Free text file]

Not used/included

Q. If **cancer screening** is in your document, please select indicators included (multiple choice)

R: Screening participation rate

Number of fecal immunochemical test (FIT) kits returned/FIT kits delivered

Recall rate "advised to undergo further assessment"

False positive

Compliance with recall (participation with a previous false-positive result)

Detection rate

Yearly invitation coverage (proportion of the people who should have received an invitation)

Weekly response to the invitation (e.g. people screened within 40 days)

Weekly screening interval (months between current screening and previous screening)

Other indicator [Free text file]

Not used/included

Q. If **screening of non-COVID-19 infectious diseases** is in your document, please select indicators included (multiple choice)

R: Difference of HCV analysed samples between pandemic waves (percentage of change)

Testing volume (e.g. HCV, HIV, HPV)

Other indicator [Free text file]

Not used/included

Q: How are the indicators mathematically expressed? (multiple choice)

See document: https://bit.ly/3tDT4xC (pages 18 and 19)

- Proportion: This is when the numerator in a subset of the denominator. Usually expressed as a percentage.
- Rate: The numerator is the absolute number of occurrences of the event being studied in a specified time. The denominator is the reference population (or population being studied) at the same time.
- Count: gives the number of occurrence of the events being studied, within a specified time and specified place.

R: Proportion

Rate

Count

Q: What is the type of data sources used to provide data to the indicators? (multiple choice)

R: Primary data sources (COVID-19 epidemiological survey/registry or In-house databases and serological surveys)

Secondary data sources (census, national registries or hospital admission records)

Q: What is the type of area of reference used to provide data to the indicators? (multiple choice)

R: National/Country

Region/county/department

City/municipality

Q: What is the type of reference period used to provide data to the indicators? (multiple choice)

R: Specific period (e.g. between October 2020 to January 2021)

Month

Week

Day

Q: Are the indicators stratified by any of the following groups (multiple choice)?

R: Age

Sex

Comorbidities

Geographic area (country, state, province, urban/rural...)

Ethnicity

Socio economic status (SES)

Q: Which are the main strengths of the indicators (multiple choice)?

R: Assess several dimensions of the health status

Easy to calculate

Data to calculate the indicator is easy to obtain

Large sample size

Other strengths [Free text file]

Q: Which are the main limitations of the indicators (multiple choice)?

R: Reduced sample size

Different time periods limiting comparisons between populations

Mapping questionnaires (e.g. compare a single score with a longer version of a questionnaire)

Difficulties completing self-administered questionnaires in certain groups (e.g. people with mental disorders)

Measurement bias on data

Other limitations [Free text file]

Q: Any other comments

Please, add here any relevant information that could not be completed in the above items.

R: [Free text file]

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