Fifth virtual WHO infodemic management conference

2, 4, 9 and 11 November 2021: meeting report

Steps towards measuring the burden of infodemics

World Health Organization | infodemic MANAGEMENT

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Acknowledgements

Note to the reader

This report condenses discussions according to the subjects addressed, rather than attempting to provide a chronological summary. The summaries of the discussions and group work address the themes emerging from wide-ranging discussions among all speakers, and do not necessarily imply consensus unless otherwise stated.

Summaries of presentations and of points made during discussion are presented as opinions expressed; no judgement is implied as to their veracity or otherwise.

Acronyms and abbreviations

COVID-19	coronavirus disease
CPAC	Canadian Partnership Against Cancer
DOI	Declaration of Interest
EQUATOR	Enhancing the QUAlity and Transparency Of health Research
ESRC	Economic and Social Research Council
EU	European Union
GAVI	Global Alliance for Vaccines and Immunization
GIH	Global Infectious Hazard Preparedness
GSK	GlaxoSmithKline
I-DAIR	International Digital Health & AI Research Collaborative
LMICs	low- and middle-income countries
NACI	National Advisory Committee on Immunization
NATO	North Atlantic Treaty Organization
SMART	specific, measurable, actionable, realistic and time-bound
SoVC	State of Vaccine Confidence Insights Report
UN	United Nations
US CDC	US Centers for Disease Control and Prevention
WHO	World Health Organization

Executive summary

This report summarizes the themes emerging from wide-ranging discussions at the Fifth WHO Infodemic Management Conference, which was virtually conducted in November 2021. This infodemic can very broadly be characterized as excess information including, but not limited to, false or misleading information, in digital and physical environments during an acute public health event. It has led to confusion, health-detrimental and/or risk-taking behaviours, all of which have been compounded by higher levels of mistrust in health authorities and public health responses. While remaining a dynamic goal-post, the definition of what is an infodemic has been evolving with increasing degrees of precision, as leading experts concur. This Conference was squarely focused on this foundational issue.

Measurement must be the foundation for a verifiable, systematic and scientific approach to ameliorate the proliferation of excess information. The overall aim of the Conference was to determine a path forward on how to measure the burden of disease due to the infodemic. Experts agreed that these gaps in metrics must be filled by connecting exposure to the required information with health outcomes. Proposals for a common intellectual vocabulary, concepts, standardized study designs, measures and tools to estimate the burden of infodemics or the effectiveness of interventions for infodemic management were explored. Why, it may be asked. Simply put, the absence of well-defined measures that can be tracked by health agencies short-change our ability to design impactful interventions and policies to mitigate the effect of infodemics on individual and public health outcomes. Further, major structural, policy and capacity challenges constrain our ability to assess the burden of infodemics at individual, societal, health system and economic levels. These, in turn, limit the potential to use infodemiology research to rapidly inform communications and other interventions aimed at reducing the impact of infodemics on outcomes, including attitudes, behaviours and health. Therefore, a consensus was reached in discussions about the central importance of metrics and frameworks related to digital information flows and online behaviours.

The details matter: several points in the information ecosystem need to be measured. The designed environment of how information is shared and spread directly impacts user behaviour, for example, content moderation policies on social media platforms, algorithmic content promotion, and the accessibility and design of user interfaces of information-sharing platforms. The multiplicity of such variables that are non-discrete, in flux and in constant interaction with each other make the identification and development of metrics an iterative and cumulative exercise.

Such metrics are instrumental in *linking* an individual's information diet to their risk perceptions, attitudes and behaviours during health emergencies and routine health service delivery. Of course, while metrics are useful, they must feed into indicators that can be considered SMART (specific, measurable, actionable, realistic and time-bound) in the contexts of their application. Notwithstanding this, **low- and middle-income countries (LMICs)** also have non-digital sources of misinformation and disinformation. This warrants both recognition as well as fundamentally novel approaches to conceptualize, measure and act upon new metrics, as appropriate.

Further downstream the metrics generation, the capacities of local infrastructures must be considered in developing infodemiology data sources, research projects or interventions. A clear recognition thus emerged that for infodemic management to be effective in the field, the **existing methods are still rudimentary** and too slow for use. Mixed methods research on infodemiology are required due to the broader information ecosystem, with its unique permutations and combinations of sources, drives and the spread, consumption and dissemination of information.
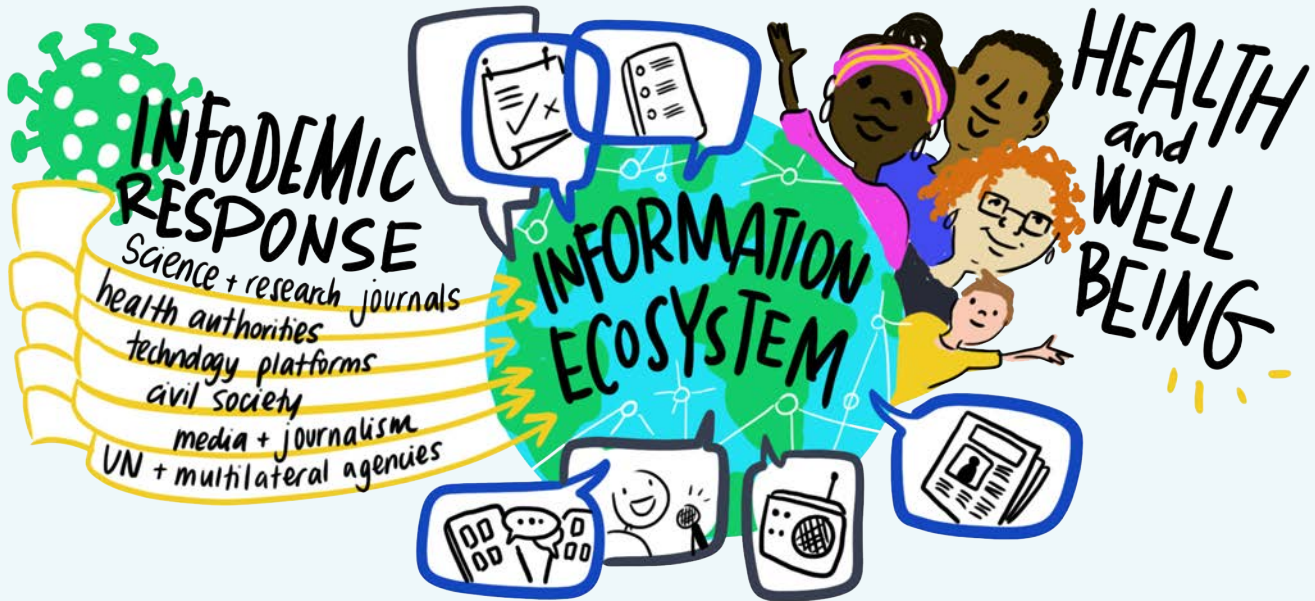
In particular, the identification of **sources and metrics from established and routine health and data systems should be prioritized**. This is because metrics can be feasible and sustainably produced if and only if they are designed for integration into routine health information and other systems, recognizing that health action may be defined based on less precise but more consistent insights over time. Therefore, a human-centred approach should be adopted in developing metrics for infodemic research and interventions. **This would call for participatory research methods and foreground the human subjects** who are the intended beneficiaries of infodemiology research and health interventions. The effort of developing metrics to produce evidence of the health burden of infodemics should be **calibrated from LMICs' health systems perspective**.

Subsequent to these perspectives on creation and aggregation of metrics comes the issue of consumption and integration of data and metrics. While this scientific discipline is growing, it is essential to **incorporate systems and platforms, and foster cultures of knowledge-sharing into infodemiology research**, even as there is an urgent need to focus on knowledge synthesis and promote awareness of currently available tools. To disseminate this information, coordinated networks of a broad range of stakeholders should be formed to **support countries and ministries of health in formulating policies and building a governmental structure to support infodemic management**.

As infodemics now constitute a condition of our times and are here to stay, **health education and early education on the various vectors of infodemics are crucial**. There is a need to **build an understanding in the public about the evolving nature of science and how public health recommendations are made and why they change. Options to strengthen public understanding of science, of scientific processes and of scientific evidence, such as plain-language summaries of research papers, should be promoted and reinforced at all levels.**

Introduction: setting the scene for measuring the burden of infodemics

Background

The COVID-19 pandemic has been accompanied by a COVID-19 infodemic: excess information, including false or misleading information, in digital and physical environments during an acute public health event. The infodemic is leading to confusion and risk-taking behaviours that can be harmful to health, as well as lead to mistrust in health authorities and public health responses. The World Health Organization (WHO) is working to develop tools to provide an evidence-based response to the infodemic to inform health response activities.

The digital information ecosystem is intertwined with social dynamics and health behaviours – it swirls information of different quality, as well as misinformation, disinformation, outdated information. People are confused because of information overload, and are frustrated over the inability to follow recommended guidance or have access to recommended health services, while the science continues generating new evidence and reshapes the emergency response by health authorities.

Previous research has explored the use of data produced and consumed on the web to inform public health officials, agencies and policy – a concept known as infodemiology. Since the first WHO Infodemiology Conference in June–July 2020, the working definition of infodemiology has expanded beyond studying the digital information ecosystem to include an integrated understanding of the online–offline information ecosystem and behaviours leading to health outcomes. The Conference examined an information ecosystem where online information flows and people's information diets can lead to poor health outcomes offline. Therefore, cross-disciplinary and mixed methods approaches are needed to inform the health emergency response *(1)*.

WHO, in collaboration with partners and stakeholders, had previously developed and published the *WHO public health research agenda for managing infodemics*. Previous conferences on infodemic management had expanded our understanding of infodemic drivers and social listening approaches.

Problem statement

Due to the multifaceted impacts of infodemics on health and society, understanding and controlling infodemics to support uptake of vaccines, public health and social measures, treatments and health behaviours is rapidly becoming a priority for many health authorities. Individual actions can cumulatively lead to severe impacts on communities, and a lack of interventions and policies can trigger catastrophic outcomes (e.g. overflowing emergency room admissions, popular opposition to health guidance, or a collapse of trust in health authorities). It has therefore become imperative to find ways to clearly discern and demonstrate the burden of infodemics on our individual and collective health outcomes.

To help health authorities design interventions that are more impactful, metrics and frameworks related to digital information flows and online behaviours are needed to demonstrate their influence on risk perceptions and protective actions during health emergencies. These are instrumental in linking an individual's information diet to their risk perceptions, attitudes and behaviours during health emergencies and routine health service delivery. The absence of well-defined measures that can be tracked by health agencies short-change our ability to design impactful interventions, and institute effective policies to mitigate the effects of infodemics on individual and public health outcomes.

There are, however, major structural, policy and capacity challenges that currently constrain our ability to assess the burden of infodemics at individual, societal, health system and economic levels. These, in turn, limit the potential to use infodemiology research to rapidly inform communications and other interventions aimed at reducing the impact of infodemics on outcomes, including attitudes, behaviours and health.

There are no standard metrics used for reporting in infodemic management to WHO or at the national level in most countries, even as the COVID-19 infodemic continues to manifest in different and complex ways across countries. At the same time, health outcomes and behavioural indicators from health data reported at the country level are not yet used to inform high-intensity individual-level studies.

Ongoing research studies in the emerging field of infodemiology also manifest some key gaps in terms of informing public health action.

- Despite the rapid growth in the number of published data-driven infodemiology studies, very few have robustly linked information exposure risks with measures of attitudes, behaviours or health outcomes.

- The way information access, exposure and engagement are estimated for individuals is inconsistent across studies and often restricted to single social media platforms, limiting the value of the research.

- It remains unclear whether data from social media and web platforms can be used as proxy measures for a person's broader information diet, and whether these data capture differences in how people make sense of that information in terms of attention, trust and prior beliefs.

- There is a lack of evidence on how exposures and interventions work when they are deployed at scale or through different interfaces.

- There are very few published studies that reflect on how policies foster or hinder infodemic-related health outcomes.
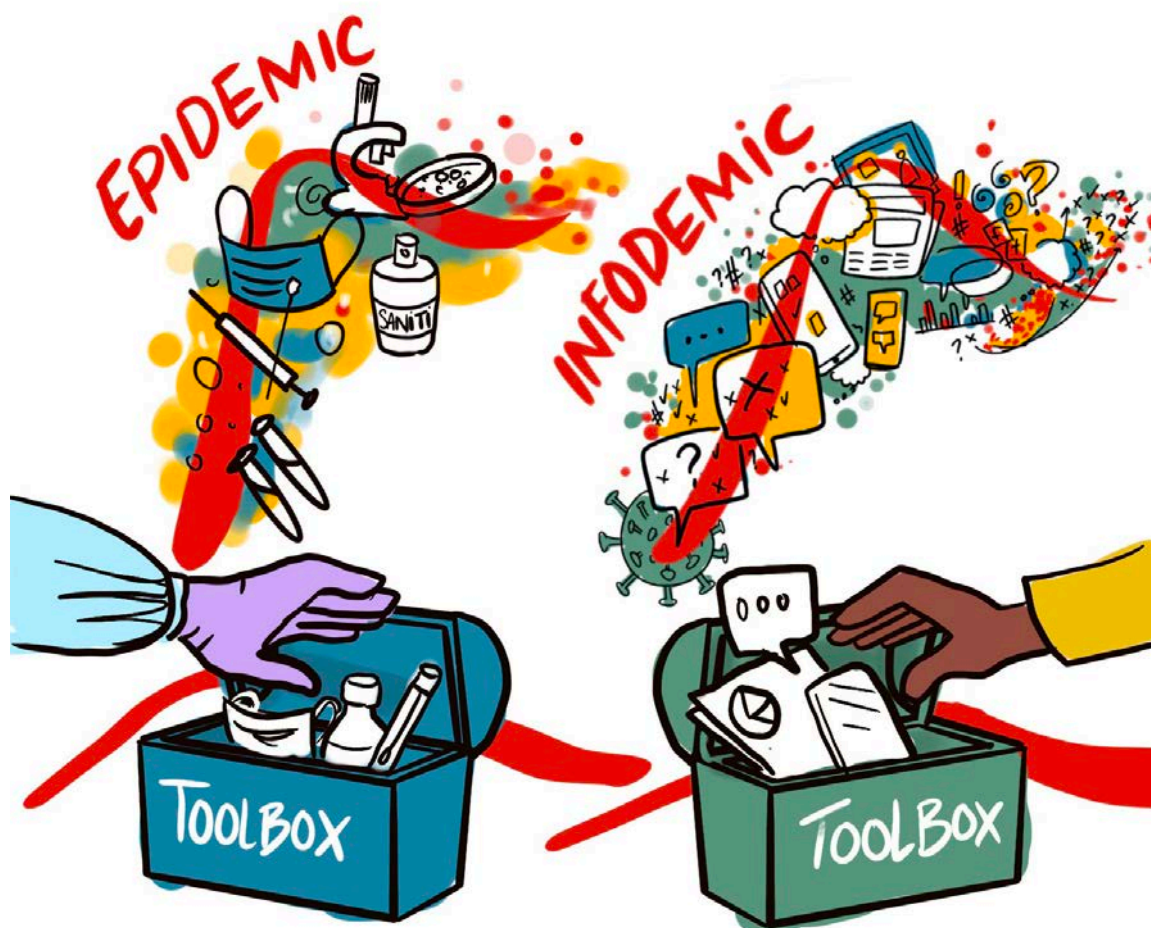
Aims and objectives

The Fifth Infodemic Management Conference was organized to develop a workplan to foster implementation of work stream 1 of the _WHO public health research agenda for managing infodemics_ – the development of metrics and indicators for measuring the burden of an infodemic and related interventions.

The burden of infodemics in different health and country contexts can be measured only when tools and collaborations are established to determine the associations between information consumption and behaviours. New ways to characterize information exposure and health outcomes need to be developed that:

- utilize validated survey instruments to measure attitudes or behaviours;

- deploy standardized and easy-to-use tools so that studies can be deployed quickly for the purposes of monitoring and surveillance;

- translate health outcomes and impact into cost–effectiveness studies for policy planning.

To achieve the above, the technical meeting discussed the gaps in the metrics required to connect exposure to information with health outcomes. It also discussed the need for proposals for a common language, concepts and standardized study designs, measures and tools that can contribute directly to estimating the burden of infodemics or the effectiveness of infodemic management interventions that can be explored.

The overall aim of the Conference was to determine a path forward on how to measure the burden of disease due to the infodemic. This can be undertaken by WHO, health authorities, academia and other infodemic management stakeholders.

Conference participants included 71 experts from 28 countries, across all WHO regions. The participants came from 46 organizations: 41% academia, 26% WHO, 24% health authority, 5% technical cooperation partners and 4% civil society

Participants

A diverse group of academics, scientists and public health decision-makers were invited to the Conference to collaborate and work at charting a path towards the measurement of the burden of disease associated with the infodemic. This was in recognition of the complex and multidisciplinary approaches that would be needed to find new ways of conceptualizing, characterizing and linking information exposure to health outcomes.

Conference participants included 71 experts from across academic and research institutions, health authorities, civil society organizations and technical cooperation partners. The participants came from 46 organizations (41% academia, 26% WHO, 24% health authority, 5% technical cooperation partners, 4% civil society), and from 28 countries from across all WHO regions. An extended conference organizing team comprising 32 members was drawn from across WHO, US CDC and the George Institute for Global Health, India.

Meeting format

The virtual Conference spanned four half-day working sessions on 2, 4, 9 and 11 November 2021. Each meeting was of a three-hour duration, held between 1300 and 1600 Geneva time. The Conference was held online via the Zoom platform. The four technical meetings were open only to invited participants and organizers.

Conference overview

Meeting proceedings

The four days of meetings and discussions at the Conference were structured over the following thematic areas:

- Session 1: Current state of play in measurement and metrics for managing infodemics
- Session 2: How do we measure information diet and information exposure?
- Session 3: How do we link information exposure to outcomes and impacts?
- Session 4: Review of deliberations and workplan going forward.

Each working session of the Conference comprised a plenary component followed by a breakout group discussion component. Over the plenary sessions, 13 discussants shared their insights and experiences in measuring and responding to the burden of infodemics. Together, these experts offered a broad overview of the kind of tools, data sources and methodologies currently being deployed in infodemiology research, particularly with reference to the topic of measurement.

For the breakout discussions, participants were organized into smaller groups to brainstorm and respond to a set technical task around the theme of the given meeting session. A concept map that considered the inputs required to calculate the health burden of infodemics was used as a structured aid to facilitate streamlined discussions. The highlights and outcomes of each discussion were briefly reported back in the plenary by the group facilitators, so that all participants were abreast of significant observations.[a]

Discussions in both plenary and breakout sessions were conducted under the Chatham House Rule to promote free exchange of information, ideas and views among participants. Participants also used the chat feature on Zoom and group messaging on WhatsApp to share insights, responses and views on the meeting proceedings, as well as larger emerging developments around infodemic management.

In addition to the plenary sessions, the breakout groups generated over 15 hours of discussion time over the four technical meetings. The Conference working sessions thus brought together a unique confluence of perspectives on approaches, technicalities and priorities of measuring the health effects of infodemics.

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[a] More information on the structure and methodology of the Conference are available in the annexes included in this report.

A multidisciplinary perspective

Over the course of the Conference, discussions progressively deepened as participants brought diverse expertise and a wealth of experience to the technical challenge of developing metrics for infodemic management. The invited experts were situated across disparate disciplinary areas of expertise, practice settings and locations, and thus engaged with distinct approaches to and methodologies of infodemiological research and practice.

Conversations over the breakout groups were exploratory during the initial sessions of the Conference. The heterogeneous mix of academics with training in different disciplines, health authorities and public health professionals working on the ground with health infrastructure of varying capacities made for distinct orientation towards priorities, design and outputs of infodemiology research. However, a common language and mutual understanding rapidly evolved as the Conference progressed, and discussions in the latter sessions were streamlined with inputs from Conference participants and design facilitation by the Conference organizing team towards specific steps and actions to facilitate the measurement of infodemic burden.

Overall, the plenary talks, breakout discussions and online chats highlighted a wide range of narratives, thematic concerns and principles that were key towards making the burden of infodemics measurable. This diversity and multidisciplinarity of expertise, in particular, generated rich insights and counterpoints on the processes and priorities involved in the identification and development of specific metrics to measure infodemic burdens.

Taking measure of the task

While calculating the harms to health outcomes caused by infodemics is a necessary long-term goal, participants quickly acknowledged that this constituted an exceedingly multilayered and technically complex task. This was owing to the variable forms and manifestations of infodemics in the field, as well as the interdisciplinary nature of its measurement, which would likely necessitate the collaborative engagement of research paradigms and tools across multiple disciplines.

A concept map on the burden of infodemics was used to delineate and introduce participants to the basic elements of and relations involved in the exposure and uptake of information on one end, to health impacts and societal costs on the other.[b] The map reaffirmed the inherently interdisciplinary nature of the issue, as processes tracked a wide expanse of disciplines ranging from the social sciences to health informatics. Consequent discussions around the technicalities of formulating appropriate metrics for infodemiology also reaffirmed that the problem of infodemics resists articulation through the tools and frameworks of any single existing discipline.

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[b] More information about the burden of the infodemic concept map can be found in the annexes of this report.

The Conference facilitators walked the participants through the concept map (Fig. 1), from left to right, as follows:

Information ecosystem: measuring the health impacts of infodemics necessitates the identification and development of metrics along several points in the information ecosystem – the content and quality of information, types of exposure and subsequent engagement upon exposure. Additionally, the designed environment of how information is shared and spread directly impacts user behaviour, e.g. content moderation policies on social media platforms, algorithmic content promotion, and accessibility and design of user interfaces of information-sharing platforms. These metrics would have to factor in variables that are non-discrete, in flux and in constant interaction with each other.

Individual: between an individual's information diet and their health behaviours is the question of myriad factors, including personality, attitudes, sociopolitical contexts, cultural beliefs and other traits – which inform an individual's cognitive processing and consumption of the information they are exposed to. The task of measuring the infodemic burden would also require the development of appropriate metrics to describe and assess the influence of cognitive, social and psychological factors that affect individual uptake and processing of the said information and its translation into health behaviours.

... while harmful health outcomes might be ascertained with reference to several existing indicators, one primary challenge is to establish causal links of the said outcomes to the quality and quantity of information exposure in a given setting and how it impacts behaviour.

Health system: while harmful health outcomes might be ascertained with reference to several existing indicators, one primary challenge is to establish causal links of the said outcomes to the quality and quantity of information exposure in a given setting and how it impacts behaviour. Existing models for behavioural research are conducted in carefully controlled settings, which seek to isolate the effects of variables on an isolated and largely homogeneous group of research participants. The utility and scalability of such models to ascertain the effects of infodemics at the population level remain untested. Moreover, metrics around the processes of psychosocial cognition add many orders of complexity to the establishment of robust causal relationships between information exposure and health behaviour, actions and outcomes.

Societal: finally, infodemics manifest differently across countries and are contingent upon any number of particulars of political, social, economic and cultural contexts. Therefore, not just the effects but even the relevant drivers of information overload, patterns of information-sharing, including mis- and disinformation, vary widely across societies. Systems of political and health governance, historical and contemporary patterns of trust in government and health authorities, public attitudes towards vaccination and other health programmes, investments in scientific institutions, cultural and social authority of scientists and health-care workers, the degree of press freedom and censorship, would likely vary greatly but constitute key factors shaping the course of infodemics on the ground.

Given these theoretical and logistical challenges, it was considered that the identification and development of metrics was likewise bound to be an iterative and cumulative exercise, involving multiple rounds of planning and execution.

Fig. 1 Concept map of the burden of infodemics as discussed at the Conference
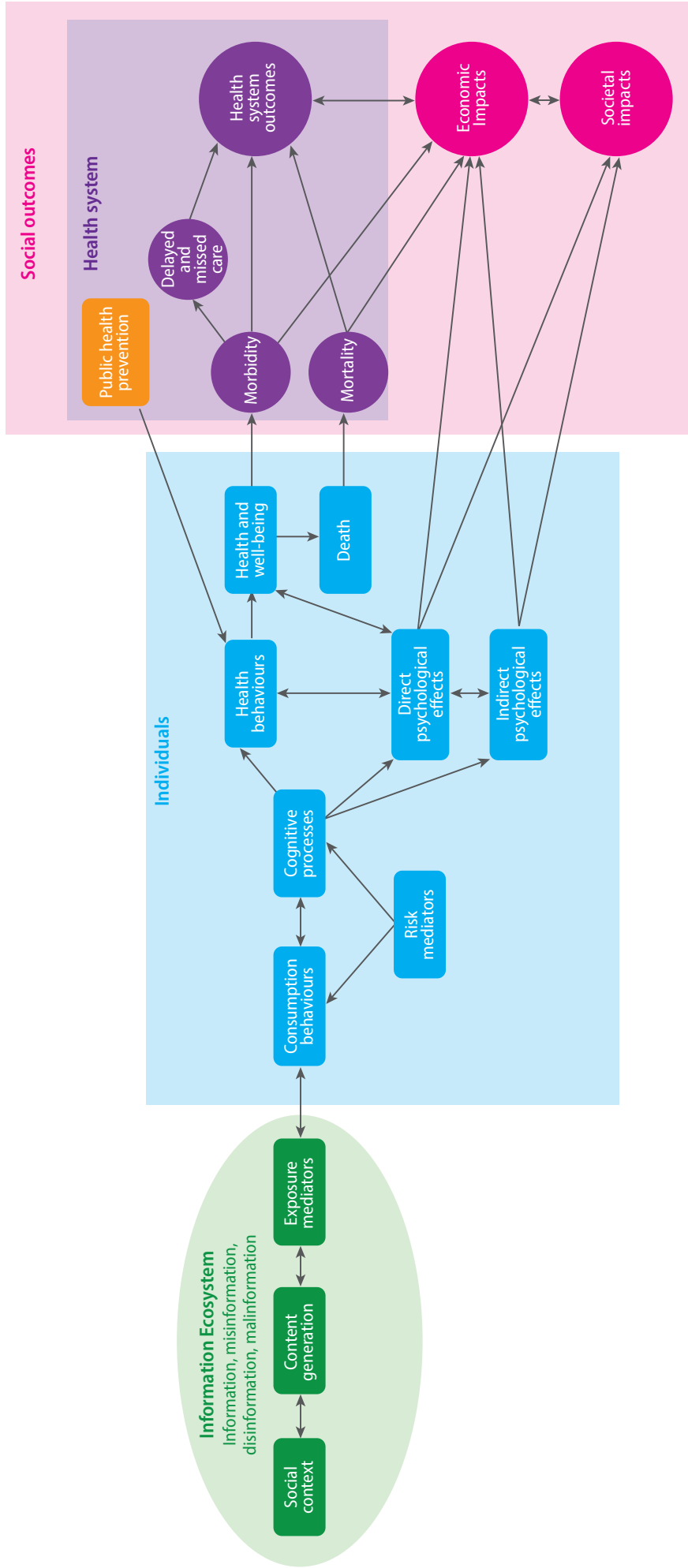
A high-level summary of perspectives on measuring the burden of infodemics

Guiding principles for measuring the burden of infodemics

Like much else with the COVID-19 pandemic, it was clear early on during the discussions at the Conference that known and established modes of public health practice and research would not yield the necessary tools to measure or manage infodemics effectively. This challenge was simultaneously recognized as an opportunity to rethink the models, assumptions and processes of conducting research, producing evidence and practising public health that are needed and would be best suited to respond to infodemics and de-escalate its health-effects. The following themes emerged through discussions.

Infodemiology research should be fast-tracked and oriented in directions that are most effective for infodemic management in the field. The development of metrics to measure and mitigate the health burden of infodemics is one such need. Models that will aid in the design and evaluation of interventions for responding to an infodemic are another. Studies that are timely and relevant for formulating evidence-informed actions and the development of evidence-based policies towards mitigating the health effects of infodemics should be prioritized, as opposed to the testing of hypotheses of largely academic import based on more readily available sources. For example, computational analytical methods have been developed to text mine the themes and sentiment on data from publicly available Internet platforms, but less has been developed to characterize and understand online interactions and narratives through images, videos and other non-textual expression, including memes and emojis, which are a language of their own. Unfortunately, existing methods are still rudimentary and too slow for use in public health emergencies.

Efforts to formulate metrics for assessing the burden and evaluating interventions related to infodemics should proceed in a parallel, and not in a conventional sequential fashion. Given the scale of the infodemic and its probable health impacts in the short- and medium term during the COVID-19 pandemic, moving sequentially from producing evidence to taking public health action is neither useful nor timely. Similarly, waiting for research studies to first establish robust causal relationships (e.g. between a particular kind of information exposure and health impact) before designing interventions and evaluating their impact involves long wait times with potentially high costs for inaction. Efforts to determine associations of information exposure to public health outcomes, as well as develop tools to inform health responses and interventions, must proceed in parallel. This means that there should be an increased focus on implementation research and participatory methods for development and evaluation of interventions for infodemic management.

*This challenge was simultaneously recognized
as an opportunity to rethink the models, assumptions and
processes of conducting research, producing evidence
and practising public health...*

Metrics that are feasible to measure and implement across a wide range of public health programmatic settings should continue to be prioritized. The ideal metrics would feed into indicators that can be considered SMART (specific, measurable, actionable, realistic and time-bound) in the contexts of their application. The capacities of local infrastructures must be considered in developing infodemiology data sources, research projects or interventions. Finally, metrics should be developed with an eye on how they will be used to inform public health action, and how local data might be sustainably harnessed to promote and inform national and global health policy action.

The identification of **sources and metrics from established and routine health and data systems should be rigorously prioritized** over the formulation of new ones. It was acknowledged that the specific country context – for instance, differences between high-income countries and LMICs—would have tremendous implications for what types of data and sources could be considered routine or available. As in other health monitoring, metrics can be feasible and sustainably produced only if they are designed for integration in routine health information and other systems, recognizing that health action may be defined based on less precise but more consistent insights over time. This should be factored into the demand for indicators that can be considered widely relevant and yet common across health systems infrastructure of varying capacities. Nonetheless, a steady focus on data from routine health systems will be key to minimizing the burden of reporting, thus promoting the sustainability of metrics for monitoring infodemics.

Integrating insights from online and offline sources of information would be key to getting a true measure of the infodemic burden. There is a well-established trend towards digital and online environments in people's information diets in recent times. However, as attested to by public health practitioners working on the ground, many individuals and communities, particularly vulnerable ones, continue to rely on traditional media outlets and/or other offline sources (e.g. extended social groups or conversations with health workers) for information pertaining to their health decisions. The non-discrete nature of these engagements with traditional media and offline sources of information would potentially require the development of a distinct set of metrics, listening systems and analytical tools. However, it is vital to ensure that offline sources of information are included in developing metrics and models to assess the health costs of infodemics, and not blindsided by an overwhelming focus on social media, which will always show only a partial view of the entire population and its interaction with infodemics.

The nature of the broader information ecosystem, particularly in its mix of sources and drivers of information creation, spread and consumption, necessitates the use of mixed-methods research in infodemiology, wherein qualitative aspects and methods of investigating infodemics are developed alongside quantitative metrics. A mixed toolbox of digital methods—including automated narrative detection, online interaction and sentiment analysis, and online ethnography—could be deployed to identify areas and topics that merit further consideration and analysis by health authorities. Given the need to examine how people are producing content, searching for information and engaging with content, tools such as machine learning, rapid community assessments and social network analysis could also be useful to better understand how content/information is being distributed.

A human-centred approach should be adopted in developing metrics for infodemic research and interventions. This would call for participatory research methods and foreground the human subjects who are the intended beneficiaries of infodemiology research and health interventions. It would also orient attention to questions such as who comprises key audiences and influencers, and the network of relationships (strong and weak ties) that motivate their health behaviours. In addition to constituting an ethical principle for public health practice, participatory research can elicit important insights and findings—for instance, around stigma as a determinant of health behaviours—that are near impossible to capture through quantitative metrics or data on social listening.

The effort of developing metrics to produce evidence of the health burden of infodemics should be calibrated from the health systems perspective of LMICs. Often only lower-quality and more limited resources and data are available to develop responses to emerging health situations, including those accelerated by infodemics. Developing more rigorous evidence and better-quality data sources with a higher degree of precision and causality are desired, but these are either entirely unavailable, or are too costly in terms of health systems resources and the health consequences of delayed action. In high-income-country settings, which may have higher-quality, more diverse and larger data sources, the challenge is to access and analyse them, and act on the insights. At the same time, LMICs might not have the data, human resources or expertise to perform health status analysis *(2)*, and infodemic impact is no different even if it is straining the health system or leading to clear examples of adverse health outcomes. This demands standards for evidence generation and evidence-informed action and/or policies that are realistic in health emergencies and strengthen systems that work across health infrastructures with very disparate resources and capacities outside emergencies.

It is essential to incorporate systems and platforms, and foster cultures of knowledge-sharing into infodemiology research, even as the scientific discipline is growing.

Developing ecosystems for data-sharing and knowledge synthesis

Stronger links between infodemic research and public health action are needed with a focus on the processes of knowledge-sharing and synthesis to prioritize evidence-informed public health action. After all, metrics are required not only for emergency response and emergency preparedness (i.e. to continually monitor the health impacts of infodemics and identify emerging topics of concern), but also for prevention and support for routine health programming.

It is essential to incorporate systems and platforms, and foster cultures of knowledge-sharing into infodemiology research, even as the scientific discipline is growing. The current state of infodemiology research and infodemic management has not prioritized knowledge-sharing and efforts are fragmented, so that most agencies are unaware of findings from research studies and social listening initiatives being run by other agencies. A number of studies and initiatives are currently under way on many different aspects of the infodemic, but with little dissemination of knowledge outside the organizations or networks involved in their production.

While more research is undoubtedly required, there is an urgent need to focus on knowledge synthesis and promoting awareness of currently available tools as options for systematic implementation towards infodemic management. In this spirit, participants discussed reassessing the ways in which evidence from the sciences is currently produced, published and disseminated, with an eye to whether these are amenable to rapid uptake and use for public health responses and programming, and any steps that can be taken to facilitate the same.

To this end, there is a need to collate and build repositories of available information across datasets, sources, tools and policies being used for infodemic research and management (in line with Conference outcome #3). Stronger systems of knowledge synthesis would reduce overlap/duplication of research efforts and also help a wide range of public health practitioners to implement evidence-informed interventions. Coordinated strategies that allow for greater transparency and better data- and knowledge-sharing are needed to ensure

that public health and infodemic management stakeholders are kept up-to-date about current research, programmes and findings, and use it in their own work. This knowledge-sharing would ultimately also accelerate our ability to demonstrate evidence of the health effects of infodemics on local and national policy-makers.

Putting infodemics on the health advocacy and public health action agendas

Coordinated networks should be formed to engage a broad range of stakeholders to promote the visibility, awareness and action around the health costs of infodemics. More advocates, stakeholders, professional health- and patient-centred organizations need to be involved in setting and implementing the agenda for the development of research instruments and outputs to produce evidence of the health burdens of infodemics and use them (in line with Conference outcome #4). Networks similar to the WHO-hosted Vaccine Safety Net or Africa Infodemic Response Alliance ought to be established globally and regionally for coordinated brainstorming, knowledge-sharing, and actions to address infodemics more effectively. These networks would be more responsive to country and regional needs and priorities in infodemic management and coordinate public health action. They would also reflect a wider and increased ownership of the issue, in which infodemics are a shared problem that require multisectoral solutions.

The first infodemiology conference in June–July 2020 brought together experts from a range of disciplines to begin the global conversation on the science of infodemiology and establish a public health research agenda for managing infodemics, recognizing that each discipline has a different perspective on the problems of infodemics, different ways of measurement and a different vocabulary. The November 2021 *Fifth WHO Infodemic Management Conference* sought to bring together a diverse group of experts to discuss the metrics and measurement of the burden of infodemics. The metaphor used in both conferences was that of the old Indian fable of several men touching different parts of the elephant and reporting on a small part of a larger whole – reporting on touching a tree stump, a banana leaf or a rope, instead of a leg, an ear or a trunk of the elephant.

These networks could also support countries and ministries of health in formulating policies and a governmental structure towards supporting infodemic management. This would necessitate engaging a diverse team across academia and practitioners, particularly as, at the time of writing, no government has a dedicated routine unit for infodemic management, even though infodemic management functions have been stood up in the COVID-19 emergency response strictures (87% of 112 responding WHO Member States reported in Q1 2021 responding to the COVID-19 infodemic and health misinformation *(3)*). Networks would be well placed to promote the formation of an infodemic governance model, with a focus on all four components: the information ecosystem, individual, health system and societal levels of impact.

Definitions and metaphors for metrics

Given that infodemics constitute complex objects of scientific inquiry, it is imperative to outline common conceptual frameworks and operational definitions to aid the development of metrics to ascertain their burdens. It becomes essential to reflect on the heuristic frameworks and terminologies in use to speak to and of infodemics, which will inevitably determine how they are measured. Being deliberate on the nature and defining charcteristics of infodemics and the analogies used to articulate them help to provide a more universally understood frame of measurement and mitigation of harm and risk.

The scope of the term "infodemic" should be clarified. Many ideas and interpretations of "infodemic" are presently conflated, such as whether the state of an infodemic is denoted by the poor quality of health-related information in circulation in a given context, or alternatively encompasses the expanse of health-related harms caused by the said information and environments, especially during health emergencies. This will have a bearing on what we look to measure when we measure the burden of infodemics. Therefore, an updated, universally agreed upon scientific definition is needed.

This time around, the experts brought different measuring tools and held a discussion about the entire elephant.

In a similar vein, **standardized definitions to establish a common understanding of the various terms used to discuss infodemics would be a key step to measuring the health burden of infodemics** (in line with Conference outcome #1). For example, a common framework would help establish exactly what constitutes misinformation or disinformation, risk, designed environment or information overload. Similarly, since an "overabundance of information" is a relative concept, it is crucial to articulate what the overabundance is relatively defined against. It is also important to define what health information is absent or inaccessible (i.e. information voids, hard-to-reach populations) when considering the development of metrics. Standard terminologies need to be expanded to capture various dynamics and degrees of quality of health information – for instance, true but outdated information, incomplete information, malinformation, and so on.

The methods by which mis- and dis-information can be quickly identified as such by users should also be deliberated upon. Assessing the quality of information on the basis of specific misinformation techniques in the content – such as expert impersonation, emotional manipulation, recourse to conspiracy theories – might be advocated, in place of evaluating truth of content, or trustworthiness of news source, which can often be harder to arrive at for a lay person. Building individual and collective capacity to identify mis- and disinformation through the presence or absence of such specific techniques would help inoculate against the effects of infodemics, even as the state of scientific evidence and facts related to a health emergency evolve.

... standardized definitions to establish a common understanding of the various terms used to discuss infodemics would be a key step to measuring the health burden of infodemics...

Understanding an infodemic as a one-off phenomenon, or one that is discrete and contains events that can be stopped, should be replaced with a recognition that infodemics are here to stay but can be managed and mitigated with the right strategies during an emergency or acute health event. The latter would be more productive for the development of long-term measures and ways of living with infodemics – focused on neutralizing the debilitating effects of information voids, information overload, uncertainty, mis- and disinformation, building individual, community and health systems resilience to them, and building and maintaining trust between populations and health systems.

The burden-of-disease metaphor invokes specific ways of articulating the nature of the burden and costs incurred from infodemics, as well as the ways of measuring, monitoring and responding to them. While recognizing its utility in thinking through and mapping the multidirectional and multilevelled dynamics of infodemics, **care should be taken not to overcommit to any single metaphor or heuristic shorthand while exploring ways of mapping and calculating the impacts of infodemics.** Doing so might rule out alternative analogies, which could suggest distinct but viable conceptual frameworks, research tools and governance models to monitor infodemics and respond to their effects.

An alternative analogy, for instance, might liken the health effects of infodemics to those of spurious treatment or mistreatment, instead of a disease. This could be productive in mobilizing the robust and well-established frameworks of digital pharmacovigilance to describe, analyse, monitor, regulate and respond to the uptake and unintended effects of a given product/intervention towards monitoring the trajectories and responding to the effects of specific pieces of mis- and disinformation. Similarly, **another alternative formulation might be borrowed from the discourses of environmental health**, wherein mis- and disinformation might be perceived as analogous to pollutants in an environment, while the state of an overabundance of information might be productively likened to oxygen toxicity. Using multiple analogies to think through and map infodemics would multiply the research tools, methods and outputs at our disposal.
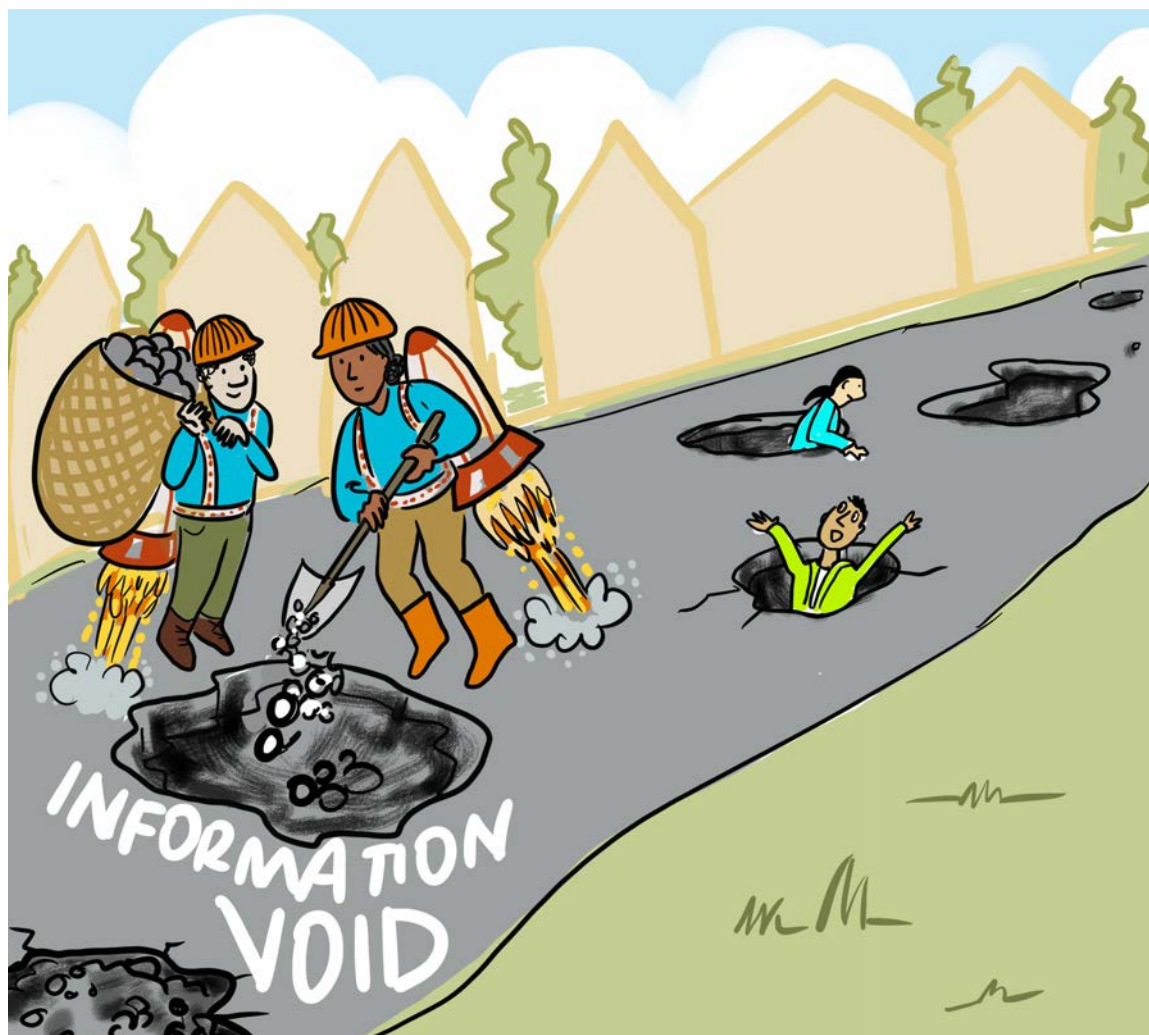
Measures for mitigation

Alongside developing metrics to capture the health burden of infodemics, we need to move towards building systems and societies that are resilient to infodemics, so that its burdens are minimized. Here, it is important to be mindful of the scope of infodemics; namely, that infodemics are not confined to mis/dis/information but are also about coping with an overabundance of information, which includes true and accurate information as well as questions, concerns and information voids. While effecting measures to neutralize the effects of mis- and disinformation, we simultaneously need to develop better strategies to navigate environments that are unevenly delivering and exposing individuals to health information and influencing how they interact with it.

As infodemics now constitute a condition of our times and are here to stay, health education and early education on the various vectors of infodemics are crucial. There is an urgent need to integrate health literacy, including education, on how to search for and assess information from an early stage, just as the importance of healthy foods and healthy lives are now a routine part of primary education.

There is a need to build an understanding among the public about the evolving nature of science and how public health recommendations are made and why they change. Rapidly addressing information voids around specific topics is one of the key actions to address questions and concerns, reduce confusion, and prevent and counter mis- and disinformation. This will be key to retaining public trust in health authorities and governmental agencies that manage a health emergency and supply reliable and timely health information and advisories, even in the face of changing evidence. It is important to follow through on making adherence to public health guidance as easy as possible and on promises made to the general public about the public health response.

While academics and experts may be well-versed in how to publish and find accurate information, more attention is needed on the ways in which even "true" information is sought, reached and processed by the public. **We need to be vigilant of the avenues and processes by which the output and evidence generated by research studies reaches the lay public and informs their health decisions.**

Two particular points of relevance emerge for infodemic management. The first comprises the ways in which the public accesses and make sense of the high-quality information in the scientific literature, especially around the reception of the findings, given their declared degrees of un/certainty and gaps. Mediators or intermediaries, such as popular press and blogs that are instrumental in setting the narrative frames around scientific evidence in their reports, constitute another point of interest. These have enormous influence over the ways in which evidence is contextualized and consumed to inform health behaviours.

Options to strengthen public understanding of science, of scientific processes and of scientific evidence, such as plain-language summaries of research papers, should be promoted and reinforced at all levels. These will ultimately function as safeguards to ensure that ongoing scientific debates cannot be easily exploited by bad actors, who cherry-pick the literature to distort available evidence for their agendas. Similarly, technical guidelines for journalists for summarizing and reporting on scientific research is another area of potential focus.

Suggestions for specific tools and instruments

Through discussions at the Conference, participants identified a number of specific instruments that might be focused on to aid the measurement of infodemic burdens. These were complementary to the research priorities identified for COVID-19 recovery and resilience building (in line with Conference outcome #5).

A tool to quickly ascertain the severity of a particular issue detected in infodemic monitoring on impacts to population health, emergency response and health systems would be useful for health authorities. This would involve assessments over several elements and vectors of information ecosystems, health behaviours and health system actions to gauge and denote the intensity of an infodemic in a given context.

Tools and metrics to describe levels of individual and/or collective resilience/ vulnerability/susceptibility to mis- and disinformation and access to health information (health information equity) should be considered. These would help to develop interventions that are appropriately tailored to increase the resilience of specific target populations in specific contexts.

Measures to assess public trust in institutions (in government agencies, health authorities, traditional media, social media, etc.), trust in evidence-based medical products, guidance and interventions, as well as in individuals (health workers, responders, community-level leaders, influencers and so on) would also be a valuable indicator of the vulnerability to an infodemic in a given setting. These could be triangulated with data on behaviour, and incorporate measures to track how levels of trust change over time, subject to infodemic/risk communication interventions.

Instruments to quickly identify and assess information voids around emerging topics that people are seeking information on would be essential for rapid responses from health authorities to counter the accumulation of mis- and disinformation around the same. We should also think about ways to measure the costs of not filling such information voids, as opposed to those of countering mis- and disinformation alone.

The COVID-19 State of Vaccine Confidence Insights Report (SoVC) *(4)*, developed by the US CDC, is one example of an instrument that compiles quantitative and qualitative data and analysis from over 14 available inputs across digital media, peer-reviewed research, polling data, social listening platforms, internal CDC data, health systems data and web metrics data. In addition to its primary purpose, the biweekly product also functions as an early detection system of specific and emerging areas of questions and concerns, information voids, mis- and disinformation in relation to the COVID-19 pandemic and responses by the American public.

Similarly, in addition to thinking about ways to measure the health, social and economic costs of infodemics, **we should think about formulating metrics to capture cost savings made from instituting infodemic management measures to accelerate investments by governments and policy-makers in the same.**

Outcomes and next steps

In preparation for the fourth and final working session of the Conference, the organizing team reviewed all the discussions and outputs of the first three sessions of the Conference. In addition to the key themes that were identified and reported in the previous section of the report, a review of the discussions revealed gaps that were mentioned in multiple breakout groups or surfaced during multiple sessions. These gaps were sometimes discussed as points of frustration, those needing further clarity or presenting a bottleneck for future work. Addressing these gaps would be a prerequisite for advancing the discussion on measuring the burden of infodemics. These gaps included the following:

1. There is a need for a common language and common definitions to describe different aspects of the infodemic and how they relate to different measures and metrics.

2. Although the concept map was useful for the discussion, it needs to be developed and validated further.

3. Although participants shared a wealth of tools and measures, the desire for a more robust landscape overview of all available evidence, tools and data sources was expressed.

4. Recognizing that the interest to support WHO in thinking about formalizing measures and metrics on the burden of infodemics, and that this expertise is outside of WHO, participants expressed a need for a way to share further developments and feedback, as well as introduce rapid expert consultation mechanisms, such as large-scale Delphi methods.

5. Participants recognized the enormity of the task of developing metrics and measuring the burden of infodemics, but also suggested prioritizing those that would be most helpful for addressing the COVID-19 pandemic and recovery efforts.

These gaps were turned into draft actions, which were reviewed and prioritized by participants over the fourth and final working session of the Conference. The five action areas and outcomes of the Conference comprised actions, timelines and volunteering commitments:

1. to develop standardized definitions;

2. to improve the concept map;

3. to conduct a desk review of evidence, tools and data sources;

4. to set up a technical working group;

5. to address the immediate priorities for recovery and building resilience from COVID-19.

The detailed discussions of the technicalities involved in each of these action areas can also be used as a working document to plan and prioritize actions within each.[c]

At the close of the Conference, WHO invited participants to continue engaging with the task of measuring and generating evidence on the health impacts and wider societal costs of infodemics.

One of such contributions by participants was an announcement of the creation of The Mercury Project, with US$ 7.5 million in seed funding from The Rockefeller Foundation, to support research and initiatives to combat the public health costs of mis- and disinformation. Overseen by the Social Sciences Research Council, this total US$ 10 million funding opportunity will accelerate investigations on the public health impacts of misinformation, as well as the evaluation of interventions to prevent its spread.

It is anticipated that the proposed technical working group on developing metrics for infodemiology will constitute an immediate avenue for continuing collaborations between academics and public health decision-makers to inform better infodemic management and public health programming.

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[c] More information and detailed discussions on each of the action areas are available in Annex 3 of the report.

Annexes

Conference meeting: methodology and structure

The agenda for each Conference working session was divided into two parts. The first half opened with remarks from the Co-Chairs and members of the organizing team, who summarized outcomes from the previous sessions and set the agenda for the day's meeting. This was followed by scientific keynote talks from three or four experts, who shared their experiences and the insights gained from conducting research into various axes of the infodemic, or from responding to the same from a public health standpoint.

The second half of each working session of the Conference was primarily devoted to discussions among participants on multiple aspects of what was needed to parse people's access and exposure to information, and its effects on health-related actions and decisions. To streamline discussion and aid participation, all participants were subdivided into groups corresponding to different breakout rooms on Zoom.

Breakout rooms and group discussions

Each breakout room was tasked with brainstorming and discussing a specific prompt around how to chart and characterize information exposure, its effects on individual and collective health outcomes, articulation of the causal relationship between the two, and the priorities going forward in the field. A brief summary of the discussion in each breakout group was then reported back at the plenary session by either the group's facilitator, or a member of the organizing team before the day's meeting was called to a close.

Discussions in breakout groups took place as follows:

- Participants were either assigned to a breakout group (over sessions 1 and 2) or chose a breakout group based on the thematic brief for each group (over sessions 3 and 4).

- They joined the assigned breakout room for the group discussion, where they were met by a facilitator and note-taker.

- The facilitator guided participants through the discussion while the note-taker noted down the discussion outputs on the Miro board sticky notes (over sessions 1, 2 and 3) or Google docs (on session 4).

- After the breakout group discussion, participants returned to the plenary session where group facilitators, or members of the organizing team, briefly reported on the salient outputs or points raised in each group.

The breakout group discussions over sessions 1, 2 and 3 were focused on refining and populating the concept map to better model the ways in which individuals are exposed to information, how they process the said information, how it informs their health-related decisions and behaviours, and how that translates into wider public health, social and economic costs at the collective level.

While the same map was used over the three sessions, participants were given distinct prompts for discussion and actions related to the concept map, and towards the identification of metrics for infodemiology.

Day 1

The concept map was introduced by members of the organizing team during the plenary session. It was subdivided into six focus areas to facilitate discussion among participants:

- Information landscape (social context, content generation, exposure mediators)
- Risk mediators
- Direct physical and psychological and indirect psychological effects, and health and well-being
- Health system outcomes
- Societal impact
- Economic impact.

Participants were also accordingly assigned to one of the six breakout groups, denoted by Groups A through F. Each breakout group discussed two parts of the concept map for 20 minutes each, where participants suggested concepts that fell into part of the assigned concept map.

After the initial 20 minutes of breakout discussions, groups were switched to different breakout rooms to discuss another focus area for 20 minutes. Given the rotation, the second focus area discussed by each group had already been the focus of another group's discussion for the first round of 20 minutes.

Observations by group members were noted on the Miro board's virtual sticky notes by an assigned note-taker in each group. Participants were free to directly add their own sticky notes to the board.

Day 2

The breakout group discussions during the second session of the Conference were also focused on the concept taxonomy map. Participants were assigned to the same group as on Day 1 to promote collegial discussion.

The following prompts were used to guide the group discussions in keeping with the session's theme of "How do we measure information diet and information exposure?"

- What are the barriers and limitations that make it difficult to measure?
- What are the measurement tools that can be used or need to be developed?
- What study designs can be used to measure this?
- What indicators could be used or developed, keeping in mind that priority should be given to existing/routine data sources to ensure sustainability and feasibility even in low-resource settings?

Day 3

Breakout group discussions during the third session were organized around the theme of "Identifying measures for each of the concept taxonomy elements".

Based on feedback from previous days' sessions, the organizing team edited the notion of a concept map, which had initially been presented as a causal map, to a concept taxonomy. Through this modification, the various elements that needed capturing through existing and future metrics were prioritized instead of characterization of the nature of the logical relations between two or more elements.

There were four breakout rooms, each assigned to a specific theme of discussion towards the identification of available and potential measures around each of the four areas of the concept map.

These were:

- information ecosystems;

- individual-level concepts;

- individual-level health outcomes;

- societal (including health system) outcomes.

Participants were free to join rooms of their choosing based upon their interests. They were also free to change rooms at any point during the discussions.

Day 4

During the final day of the Conference, participants were invited to join any breakout room of their choice. There were five breakout rooms, each dedicated to a specific task in view of the next steps to develop metrics and associated interventions for infodemic management.

- Develop standardized definitions.

- Improve the concept map.

- Conduct a desk review of the evidence, tools and data sources.

- Set up a technical working group.

- Address immediate priorities for COVID-19 recovery and resilience building.

Concept map

The highly interdisciplinary nature and the currently nascent stage of the science of infodemiology, combined with the heterogeneity of academic expertise and professional backgrounds of the participants, offered rich opportunities for multifaceted technical discussions on metrics related to infodemics. These same features also presented significant challenges in terms of establishing a common language and framework needed for streamlined and actionable discussions around the measurement of the health effects of infodemics.

A concept map was introduced during the first working session of the Conference to facilitate discussions among participants on the technicalities of developing metrics for infodemics.

What is a concept map?

Concept mapping is a technique from the social and natural sciences to represent hypotheses about how elements affect one another. These maps are meant to be preliminary frameworks; for example, concept maps typically start in a highly qualitative form, similar to mind-mapping or causal-mapping techniques. While concept maps may eventually inform the basis of quantitative research, such as structural equation modelling, highly qualitative concept maps can be helpful for nascent problems to provide a system-level visualization of potential causal links, which, in turn, informs strategies for their investigation.

Why start with a concept map?

As research on infodemiology remains nascent, there are significant variations in how infodemics and their impacts are conceptualized. The reasons for this are fourfold:

1. The interdisciplinary nature of infodemiological research draws interest from a wide variety of diverse disciplines ranging from the social sciences to health informatics.

2. Experts working in infodemiology vary in practice settings, ranging from public health action to academic research.

3. Brief reviews of the literature suggest that comprehensive frameworks for the impacts of infodemics do not exist.

4. Any research seeking to measure the predictors, mediators and impacts of either health behaviours or human cognition is intrinsically complex.

As potential impacts will likely vary from the effects on individuals to broader societal-level outcomes, a lack of consensus will hinder discussions on how to think about infodemics and measure their impacts. A draft concept map would consequently facilitate conversation during this Conference.

What was the concept map used for?

Fig. 2 is a fictitious example based on world experiences from the COVID-19 infodemic, and its interactions between health authorities, media channels and sources, how infodemics affect individuals, families and communities, and possible outcomes.

Fig. 2 Example of an evolution of the infodemic across individual, community, health system and societal levels

NEW CONFUSING PUBLIC HEALTH GUIDANCE ISSUED

media reaction

meme is generated

a medical association debunks the meme
FAKE

you get it

your uncle gets it

your uncle shares it

you decide not to share it
END

your cousin develops a meme of the medical association debunking the meme

media covers new viral meme
ON AIR

your cousin makes a meme about the uncle and is uninvited from the next family holiday

your uncle goes to an antimasking protest

extended family members continue not to use masks and share misinformation

people are still **confused**

health authority clarifies health guidance

low vaccination coverage persists

ministry of health exasperated

non-essential medical procedures are deprioritized and there's an increase in waiting lists

more emergency admissions of COVID-19 cases in young healthy unvaccinated people

more health workers burnout and quit

COVID-19 pandemic roars on

lower trust in epidemic control measures

lower trust in health system

societal

media

individual and community

(c) WHO/Trilce García Cosavalente

This concept map (see Fig. 2) seeks to provide a system-level visualization representing hypotheses about how key factors may affect outcomes in an infodemic. A synthetic map is needed as the majority of research to date has focused only on limited facets of the system; for example, one study sought to estimate the total monetized cost of decisions not to receive a COVID-19 vaccination based on misinformation or disinformation *(5)*. Another study focused on the incremental health costs due to additional COVID-19 cases caused by misinformation, as well as the impact on gross domestic product due to government restrictions needed to address the infection growth rate attributable to the impact of misinformation *(6)*.

The draft concept map presented below is consequently based on theoretical expectations, drawing from existing models from multiple disciplines, including anthropology, psychology, sociology and informatics. The concept map seeks to apply exposure or dose–relationship models from medicine and public health towards infodemic impacts, and draws from socioecological models to consider interactions between individuals and broader societal factors.

The map itself was organized into four sections, representing elements relating to the influence of information dynamics, and their attendant effects on individual health and societal impacts.

1. Information ecosystems: online and offline content, social context and the structures that affect dynamics of information consumption and transmission

2. Individual effects: behaviours and psychological mediators that determine exposure and susceptibility to information characteristics of infodemics, as well as the proximal physical and psychological outcomes after this exposure

3. Health system impacts focused on metrics and outcomes specific to health-care delivery and public health systems

4. Societal impacts: infodemic impacts and ultimate outcomes that affect groups of individuals.

In this concept map, boxes represented thematic constructs or elements hypothesized to be significant predictors of infodemic outcomes. Arrows suggested causality or influence in the direction indicated. Circles were thematic outcomes of interest to public health. Sticky notes designated ideas developed during the Conference and in small breakout groups.

Fig. 1 Concept map of the burden of infodemics as discussed at the Conference
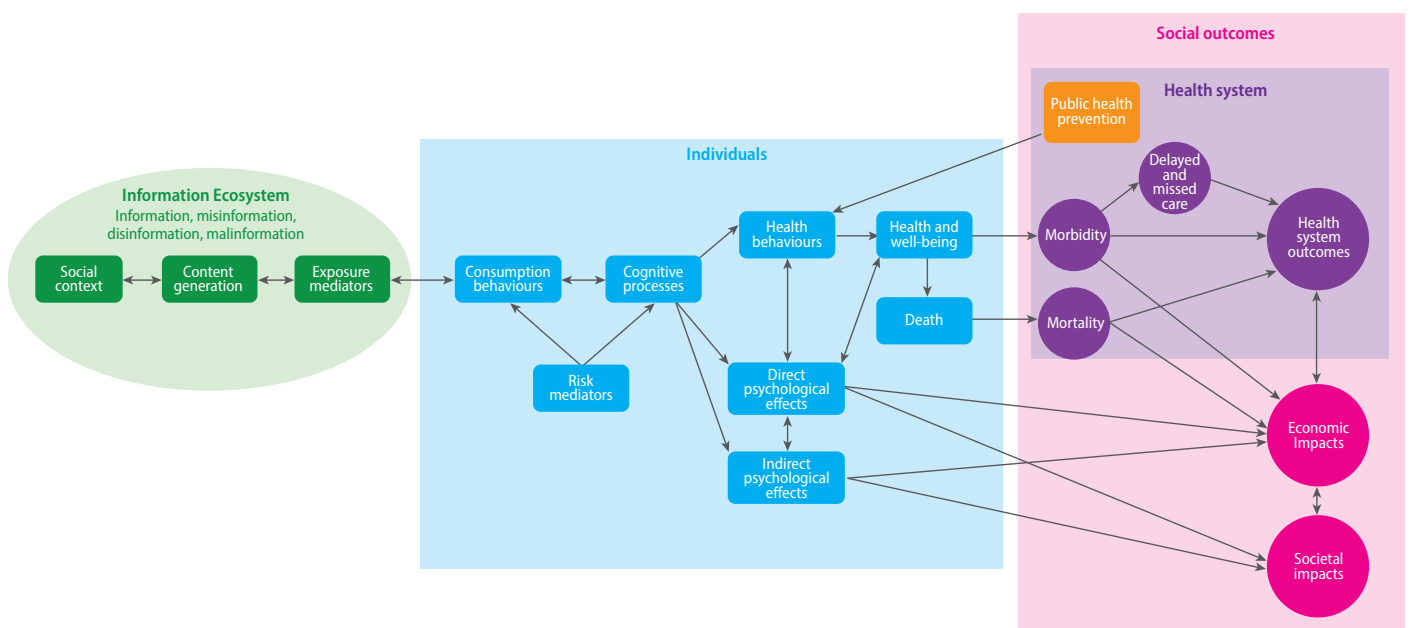
What were the limitations of the concept map?

This draft concept map had significant limitations. These included, and were not limited to, the following:

- The primary purpose of this concept map was to inform conference discussions, and should not be considered a formal model.

- Elements that were likely to be challenging to measure were included to foster discussion.

- The model was based on theoretical expectations and not a systematic review of the literature.

- The causal model was not comprehensive, and should not be used to inform intervention design or quantitative modelling.

How was the concept map used?

Different parts of the concept map were discussed over the course of the Conference in two formats: by discussants who were experts at providing perspectives on specific topics in plenary, and in small group discussions in breakout groups where all participants were asked to provide inputs on the topic.

The interactive Miro platform was used to present the concept map and capture inputs from discussions. Participants in breakout groups were encouraged to populate and edit the concept map, as per the specific facilitation instructions for the discussions. Alternatively, participants could either voice their position or make a note on the chat feature of the breakout room, and an assigned group discussion facilitator would capture the conversation through virtual sticky notes on the Miro board.

Some leading questions for the breakout groups in discussing the concept map are given below:

- What subconcepts should be added within the box on the map?

- What measures can be used to measure the concept?

- How can we prioritize adding concepts that are measurable and for which data sources may already exist?

- What are the barriers or considerations that make this harder or easier to measure in high-income countries? In LMICs? Globally?

Discussions about conference outcomes and action areas

Five key areas for immediate action towards the development of metrics to assess the burden of infodemics and associated interventions were identified over the four sessions. Participants discussed in detail the technicalities involved in implementing each, which are captured below.

1. Develop standardized definitions

Based on conference discussions, it was proposed that a set of standardized definitions related to infodemic measurement and infodemic management be developed. This would be achieved through the establishment of a working group that would develop working definitions, which could be validated through a Delphi process. The definitions would be developed in December 2021 to January 2022, and the Delphi process would run from February to March 2022.

Participants agreed that this task was a priority because at present the term "infodemic" is used to refer to many scenarios and situations. As such, it is conceptually conflated, overworked. A glossary of terms associated with infodemics – such as misinformation, disinformation or an overabundance of information – with standardized definitions was sorely needed to aid infodemiology research as well as public discourse.

Several nuances around this task were anticipated, which would need to be addressed by the working group. These included the following:

- Apart from mis- and disinformation, how should notions that such information is/was true at one point in time but has become outdated/expired in face of newer evidence, be captured in the terminology?

- Should there be a term to indicate information that is not mis- and disinformation, i.e. so-called "good" or "true" or "accurate" information?

- Should infodemics, with regard to its connotations of "excess information", be defined as a universally negative phenomenon? Where does this leave contexts in which "more information" might be adding value and fostering education rather than contributing to the reverse?

- Strong operational definitions of terms such as "overabundance of information" would be essential to develop operational metrics to measure infodemics, given the inherently relational and contextual nature of such concepts. What should be the markers of "overabundance" and what is the overabundance relative to? Is it fair to assume that individuals and societies are always overwhelmed with information?

- Is the idea of "overabundance" better applied to the magnitude of information to which people are exposed, or to the harms that are then caused? Harmful outcomes have the advantage of being easier to measure (in terms of mortality, vaccine refusals, and so on) but run the risk of abandoning the link with information exposure. Should the current definition be modified to "an overabundance of harm created through exposure to mis-, dis-, and an excess of information"?

- The question of language and the power of the translator to dictate the narrative. Along with a glossary, WHO should develop guidelines on how to translate the same into different languages. There may be many terms in a language that may have approximately the same meaning, but with different political connotations.

- Multiple terms that have approximately the same meaning are currently in use to describe infodemic-related phenomena. The duplication that happens when multiple terms are commonly used to denote essentially the same concept/ phenomenon adds to the confusion. A timely example would be "vaccine hesitancy" versus "vaccine confidence". Another would be differences in meaning between "vulnerability" or "susceptibility" in risk assessments of mis- and disinformation.

- WHO should take the lead in producing a standardized glossary that can be used to inform scientific research, technical discussions and public discourse.

2. Improve the concept map

Based on discussions at the Conference, it was proposed that a working group be established that would review and improve the concept map so that it reflects or reconciles different perspectives and disciplines that look at the ecosystem, individual, health system and societal factors contributing to the infodemic. This concept map would be validated through a Delphi process. The concept map would be reviewed from January to March 2022, and the Delphi process would run from April to May 2022.

Participants agreed that this task was a priority and voted to retain the infodemic burden concept map. They agreed on its value in identifying the various inputs and outcomes, as well as the confounding factors that determine the contours of a complex object of scientific inquiry, such as an infodemic. However, participants warned against following any concept map too closely, as it might lead to missing critical elements that were not already elaborated on the map.

A multidisciplinary steering committee should be formed to develop the concept map, and to identify stakeholders to define its elements and links. Efforts to improve the concept map should be closely coordinated with the technical working groups working on developing standardized outcomes (Conference outcome #1), and with the group conducting a desk review of the evidence, tools and data sources (Conference outcome #3). This is essential as definition of the appropriate elements in the map will be in conversation with the terminology being developed. Similarly, evidence from the literature reviews will be vital to arriving at appropriate causal connections between the elements in the map.

In terms of specific modifications, participants suggested the following:

- The map should be sensitive to the differences between mis- and disinformation and information overload, as these can lead to entirely different health behaviours and outcomes.

- Models on information-seeking behaviours should also be included in the map.

- Elements on the map should be refined so that they have the same level of granularity, instead of some elements being extremely broad and the others too narrow.

- Elements should also be reworked to make the model more broadly applicable to infodemics and health outcomes, rather than focus on a specific-use case alone, such as vaccination.

- A balance should be sought between making the concept map precise for a specific infodemic-related use case, which might help tailor better research questions, and its applicability for articulating general infodemic-related dynamics.

In terms of enhancing the utility of the infodemic burden concept map, participants made the following suggestions:

- There should be a clear understanding of and communication on who the target audience and what the target use for the map is.

- The map should be presented to select groups who did not participate in the Conference.

- A series of infodemic-related case studies, based on literature reviews, should be developed as use-cases to illustrate the analytical utility of the concept map.

- Training should be offered for different stakeholders (e.g. researchers and public health policy-makers) on how to use the map based on their specific research tools and needs. For example, the concept map might be integrated as part of the WHO COVID-19 infodemic management course.

- Future meetings should devote more time to the revision and review of the concept map, with concrete-use cases to bring the discussions together.

In sum, the infodemic burden concept map could be envisioned as a living document that is refined and evolved as infodemiology research progresses and more is known about the links between information exposure and health outcomes. This would necessitate regular reviews with key stakeholders. The review committees should be diversely constituted to avoid fatigue and keep the advantage of fresh eyes to help identify different areas of focus where further research and measurement is needed.

3. Conduct a desk review of evidence, tools and data sources

Based on the discussions at the Conference, it was proposed that a working group be established that would draft a protocol for conducting a desk review of evidence, tools and data sources related to infodemic measurement. The working group would also explore options and partnerships that could implement the desk review. The protocol could be developed from January to March 2022, and partnerships for its implementation identified by April 2022.

Participants agreed that this task was a priority. Given the emerging contours of infodemiology, its scope would extend beyond that of a traditional desk review. While drawing on tools for systematic reviews of ongoing and upcoming research, it would, for instance, also involve searches within the grey literature.

The process of compiling the desk review should be initiated by stakeholder mapping to identify networks in infodemiology research to link and reach out to. This could be followed by search query data for an idea of the data that is being collected but not shared widely, and a review of the public health interventions aimed at addressing infodemic burdens alongside a comparison with the infodemic burden concept map. Finally, experts and practitioners could be approached with additional interviews and/or surveys for a comprehensive idea of the evidence, tools and data sources currently in use.

A broad range of stakeholders should be invited to join and consulted in the desk review. Academics from across relevant disciplines, researchers at public health and communications and mass media institutes, representatives from consumer societies, social media platforms, community-based organizations, and social research institutions, including public opinion companies, should be invited. Consultants on the task might include area experts, policy-makers, health authorities, social media oversight boards, fact-checker organizations, marketing companies with a track record of studying messaging impact in terms of media and content.

In compiling a review of the existing evidence, tools and data sources being deployed in studies around infodemic burdens, particular attention should be paid to the following in knowledge synthesis:

- the choice and use of particular tools to investigate particular questions;

- the intersectional nature of the available evidence (from communication, marketing, public relations studies, and so on);

- the ways in which the digital divide (and the populations unreached by digital information) is being addressed;

- new and emerging data sources or methods;

- orioritizing evidence and measures that can be used to inform action, which are readily available, timely and associated with low costs of collection and a high confidence in the measure;

- the facilitation of a rapid critical appraisal of the evidence, tools and data sources;

- its translational aspects, focused on ways in which the nature of the information captured might be categorized and classified, so that it might be used by multiple audiences, including but not limited to policy-makers, health authorities, researchers and the lay public alike;

- its relevance at multiple levels – global, national and local;

- ways to maintain transparency and accountability with the technical working team.

A suite of complementary instruments would likely need to be developed to support the primary work of the desk review, including:

- standards to gauge and define the levels of confidence associated with specific evidence, tools and data sources;

- protocols for data-sharing, including standards for maintaining privacy/ anonymity, guidance on releasing metadata, or descriptive statistics, and coordinated negotiations with data providers;

- protocols and guidance on making databases interoperable;

- a validation exercise to facilitate the collation of a registry of validated data sources.

The desk review is an immensely collaborative task, which requires working with diverse data, languages and formats. Access to these data would likely be governed by a number of different legal frameworks that determine the ownership of data and its privacy protections. The willingness of various parties (governments, universities, technology corporations) to share relevant data might constitute another barrier. The participation of various stakeholders might be motivated by different incentive structures (non-profit organizations may want to raise funds around data findings, for instance), which must be negotiated.

A number of repositories and models – embodying specific principles, operating protocols and the objectives mentioned above – can be used as resources to inform this synthesis and review:

- Cochrane databases, for guidance on using standardized reporting and critical appraisals tools: *https://www.cochranelibrary.com*

- EQUATOR (Enhancing the QUAlity and Transparency Of health Research) network: *https://www.equator-network.org/*

- Global Research Map, which constitutes a worldwide landscape of digital health and artificial intelligence (AI) in health activity, methodologies and research via regional landscapes, done by iDAIR: *https://www.i-dair.org/launch-of-i-dairs-digital-health-and-ai-global-research-map-grm/*

- A repository focused on new and ongoing COVID-19 vaccine research in behavioural science, which was crowdsourced and curated by a non-profit research organization, without funding for the task: *https://docs.google.com/spreadsheets/d/1HrG2-ALI7Hku-T55jXGeCGm7DPsv30GOcymRnZYtZwg/edit#gid=45559234*

- CoVaxxy dashboard for misinformation on vaccines in the US, developed by the Indiana Universary Observatory: *https://osome.iu.edu/tools/covaxxy*

- Convening with newsrooms, journalists and health experts on the challenges of reporting on COVID-19 and vaccines in underrepresented communities: Takeaways from the COVID-19 Community Convening

- Reaching offline communities, working with Google News Initiative to fund global fact-checking initiatives: COVID-19 Vaccine Counter-Misinformation Open Fund.

4. Set up a technical working group

Based on discussions at the Conference, it was suggested that a working group be established to review and improve different policy, practice and research priorities on a rolling basis and work towards alignment of infodemic management efforts at the global level by different stakeholders. This group would also support mainstreaming of infodemic management into public health practice and policy. This core group would be complemented by a wider array of related groups, leveraging expertise in specific areas in a Delphi process to reach consensus on various items discussed in the group. Terms of reference could be developed by January 2022, with WHO initiating the first meeting in February 2022.

Participants agreed that this task was a priority.

A host of considerations should guide deliberations and decisions on the constitution, activities and expected impact of the working group:

- Include a wide network of individuals and institutions, representative of a wide range of actors and affected stakeholders, to minimize homogeneity and facilitate better advocacy and dissemination of work.

- Carefully select representatives from across the world and involve country-level practitioners, avoid overrepresentation by experts from areas with the maximum research funding and published literature on infodemic management.

- Include practitioners from the field to maintain focus on public health action and provide grounding on what is actionable, feasible and sustainable.

- Reach out to other working groups that are already working in this area and might be able to assist.

- Identify institutions at the regional and local levels (e.g. using the Vaccine Safety Network), whose work aligns with one or more of the proposed action areas to be part of the extended network.

- Ensure the technical and apolitical orientation of the group's work to serve all organizations and the public.

- Commit to transparency in all decisions and processes of decision-making, facilitated by actions such as a public call for members, and a collaborative approach to setting up the terms of reference of the group.

- Look to international agencies to keep the focus on developing health-related metrics in infodemic burdens, while also deciding on appropriate limits to the notion of "health".

- Specify concrete deliverables for the working group to facilitate timely assessments of its impact in advancing the field, relative to the time and resource investments incurred.

5. Address immediate priorities for covid-19 recovery and resilience building

Based on discussions at the Conference, COVID-19 response, recovery and resilience building remain the key priorities for many health authorities and continue to be a focus of research for academicians. In light of the threat of the infodemic on the world's ability to move past COVID-19, what are the most urgent aspects of COVID-19 infodemic management that we need measurements for in the next six months? Based on the discussions, four aspects were identified, which participants were asked to rank them in order of priority, in addition to offering inputs on their potential modification and expansion:

1. *Development of behavioural/process models that can be used for the development and evaluation of interventions*

2. *Measuring the economic cost of the COVID-19 infodemic and related spill-over effects*

3. *Identification of data sources and measures following the concept map, which can be used for defining global open datasets to facilitate modelling and research*

4. *Development of harmonized tools for the measurement of information diet/exposure and establishment of a global research collaboration to use them.*

Participants agreed that all aspects constituted essential work for developing metrics to measure the infodemic burden. A number of ways of ordering the priorities were put forth, subject to different lines of reasoning on why measuring the burden of infodemics constituted essential public health action.

The common priorities that emerged from the discussions, in rough order, are listed below:

1. Development of harmonized tools for measurement of the information diet/exposure and establishment of a global research collaboration to use them

2. Identification of data sources and measures following the concept map, which can be used for defining global open datasets to facilitate modelling estimation and research

3. Development of behavioural/process models that can be used for the development and evaluation of interventions

4. Measuring the economic cost of the COVID-19 infodemic and related spill-over effects.

Alternative priority actions on metrics development could involve the following:

• Developing measures to assess and capture public trust in institutions (in government agencies, health authorities, traditional media, social media, etc.), as well as in individuals (community-level leaders, influencers, etc.) and their relationship to infodemic and consumer behaviour

• Developing methods to track and measure how levels of trust change over time, subject to infodemic/ risk communication interventions

• Identifying and developing measures to assess information voids, and to determine the costs associated with the voids as opposed to mis- and disinformation alone

• Developing metrics to describe and assess the consumption of infodemic diets and ecosystems, so that the notion of information exposure is well-defined

• Developing methods to capture cost savings made from investing in infodemic management as potential incentives for policy-makers, in addition to the economic cost burdens of infodemics.

Conference programme

Day 1

Tuesday, 2 November 2021, 13:00–16:00 Geneva time

Time	Session
13:00 – 13:05	**Welcome** *Sylvie Briand*, World Health Organization
13:05 – 13:10	**Welcome** *Dimitri Prybylski*, US CDC
13:10 – 13:20	**Welcome, housekeeping and ways of working** *Tim Nguyen*, World Health Organization
13:20 – 13:30	**Start of working session** Introduction by conference co-chairs: *Neville Calleja*, Ministry for Health, Malta / *Claire Wardle*, University of Pennsylvania, USA
13:30 – 13:50	**Setting the scene – evolution of infodemic management during the COVID-19 response** *Tina Purnat*, World Health Organization
13:50 – 14:10	**Introduction to the discussion: A concept map on the main pathways on the wider effects of the infodemic (individual, society, health system and policy)** *Howard Chiou*, US CDC / *Elisabeth Wilhelm*, US CDC / *Tina Purnat*, WHO
14:10 – 14:30	**Perspectives by three discussants (10 minutes each)** *Isabella Ballalai*, Brazilian Immunization Society, Brazil / *Ashish Joshi*, City University of New York, USA / *Noel Brewer*, University of North Carolina, USA
14:30 – 14:40	**Break**
14:40 – 14:50	**Breakout group division and tasks** Group formation and division into breakout groups on zoom *Tina Purnat*, WHO / *Elisabeth Wilhelm*, US CDC Break-out group facilitators: *Sally Smith*, WHO / *Sarah Hess*, WHO / *Romana Rauf*, WHO / *Muriel Konne*, US CDC / *Nessa Ryan*, US CDC / *Shibani Kulkarni*, US CDC
14:50 – 15:10	**Discussion in breakout groups: Round 1**
15:10 – 15:30	**Discussion in breakout groups: Round 2**

Part of the causal pathway map	Round 1	Round 2
Information landscape (social context, content generation, exposure mediators)	Group 1	Group 2
Risk mediators	Group 2	Group 1
Direct psychological effects, indirect psychological effects, health & wellbeing	Group 3	Group 4
Health system outcomes	Group 4	Group 3
Societal impact	Group 5	Group 6
Economic impact	Group 6	Group 5

Time	Session
15:30 – 15:50	**Report back to plenary** *Howard Chiou*, US CDC
15:50 – 16:00	**Comments by conference co-chairs** *Neville Calleja*, MoH Malta / *Claire Wardle*, University of Pennsylvania, USA
16:00 – 16:05	**Housekeeping, schedule for next day** *Elisabeth Wilhelm*, US CDC
16:05	**Adjourn**

Day 2

Thursday, 4 November 2021, 13:00–16:00 Geneva time	
13:00 – 13:05	**Welcome by conference co-chairs** *Neville Calleja*, MoH Malta / *Claire Wardle*, University of Pennsylvania, USA
13:05 – 13:10	**Housekeeping** *Tina Purnat*, WHO
13:10 – 13:20	**Setting the scene – How do we measure information diet and information exposure** *Tina Purnat*, WHO / *Elisabeth Wilhelm*, US CDC
13:20 – 14:00	**Perspectives by three discussants (10 minutes each)** *Adam Dunn*, The University of Sydney, Australia / *Filippo Menczer*, Indiana University, USA / *Odette Wegwarth*, Charité Berlin, Germany
14:00 – 14:10	**Break**
14:10 – 14:20	**Breakout group division and tasks** Group formation and division into breakout groups on zoom *Tina Purnat*, WHO / *Elisabeth Wilhelm*, US CDC Break-out group facilitators: *Sally Smith*, WHO / *Sarah Hess*, WHO / *Romana Rauf*, WHO / *Muriel Konne*, US CDC / *Nessa Ryan*, US CDC / *Shibani Kulkarni*, US CDC
14:20 – 15:00	**Discussion in breakout groups** How do we measure information diet and information exposure? Identify top three: • What are the barriers and limitations that make it difficult to measure? • What are the tools that needs to be developed? • What study designs can be used? • What indicators could be used or developed (priority should be given to existing/routine data sources to ensure sustainability and feasibility even in low-resource settings)?
15:00 – 15:40	**Report back to plenary** Break-out group rapporteurs and facilitators
15:40 – 15:50	**Comments by conference co-chairs** *Neville Calleja*, Ministry for Health, Malta / *Claire Wardle*, University of Pennsylvania, USA
15:50 – 16:00	**Housekeeping, schedule for next day** *Elisabeth Wilhelm*, US CDC
16:00	**Adjourn**

Day 3

13:00 – 13:05	**Welcome by conference co-chairs** *Neville Calleja*, MoH Malta / *Claire Wardle*, University of Pennsylvania, USA
13:05 – 13:35	**Perspectives by four discussants (10 minutes & 5 minutes QA each)** *Theresa Senft*, Macquarie University / *Elena Petelos*, Maastricht University, the Netherlands
13:35 – 14:05	**Perspectives by four discussants - continued (10 minutes & 5 minutes QA each)** *Sander van der Linden*, University of Cambridge, United Kingdom / *Dimitri Prybylski*, US CDC
14:05 – 14:30	**Discussion**
14:30 – 14:40	**Break**
14:40 – 15:00	**Setting the scene – How do we link information exposure to outcomes and impacts** *Tina Purnat*, WHO / *Elisabeth Wilhelm*, US CDC
15:00 – 15:15	**Breakout group division and tasks** Group formation and division into breakout groups on zoom *Tina Purnat*, WHO / *Elisabeth Wilhelm*, US CDC Break-out group facilitators: *Sally Smith*, WHO / *Sarah Hess*, WHO / *Romana Rauf*, WHO / *Muriel Konne*, US CDC / *Nessa Ryan*, US CDC / *Shibani Kulkarni*, US CDC / *Howard Chiou*, US CDC / *Elisabeth Wilhelm*, US CDC
15:15 – 16:00	**Discussion in breakout groups** Identifying measures for each of the concept taxonomy elements
16:00 – 16:05	**Housekeeping, schedule for next day** *Elisabeth Wilhelm*, US CDC
16:05	**Adjourn**

Day 4

13:00 – 13:05	**Welcome by conference co-chairs** *Neville Calleja*, MoH Malta / *Claire Wardle*, University of Pennsylvania, USA
13:05 – 13:15	**Summary of the discussions so far** *Tina Purnat*, WHO / *Elisabeth Wilhelm*, US CDC / *Howard Chiou*, US CDC
13:15 – 14:00	**Perspectives by three discussants (10 minutes each)** *Antonio Parrilla*, Presidential Council of Ministers, Italy *Lucie Bucci*, Immunize Canada, Canadian Public Health Association, Canada *Marcelo D'Agostino*, PAHO / WHO Regional Office for the Americas
14:00 – 14:15	**Break**
14:15 – 14:30	**Introduction to the breakouts** *Tina Purnat*, WHO / *Elisabeth Wilhelm*, US CDC / *Howard Chiou*, US CDC
14:30 – 15:20	**Breakout group discussion**
15:20 – 15:30	**Break**
15:30 – 15:55	**Reporting from groups and implementation planning** *Elisabeth Wilhelm*, US CDC
15:55 – 16:00	**Announcement of RFP on misinformation** *Bruce Gellin*, The Rockefeller Foundation
16:00 – 16:15	**Closing remarks** *Elisabeth Wilhelm*, US CDC *Tim Nguyen*, WHO
16:15	**Adjourn**

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Summary of the review of declarations of interest by participants

Final number of participating experts: 51 (non-WHO) experts

Final number of (non-WHO) experts with disclosed interest: 15

The Global Infectious Hazard Preparedness (GIH) department, within the WHO Health Emergencies Programme, organized a closed scientific conference on infodemiology, the science behind managing epidemics, from 2 November to 11 November 2021. The overall aim of the conference was to take stock of relevant research and effective practices in metrics and measurement of the burden of infodemics to advance this field. Seventeen (17) WHO and UN staff and 54 experts from various areas of expertise were invited to attend and submit a Declaration of Interest (eDOI) form.

Three invited experts did not submit a DOI: Camille Francois, Yannick Beauvalet and Sandra Romain. They subsequently declined to participate and did not take part in the conference.

On review of the completed DOIs, 15 experts declared interests. They were assessed as non-significant by the WHO Secretariat for the purposes of the meeting. The details are as follows:

Adam Dunn declared that his university received US$ 125 000 research support by WHO. In this project, WHO owns the product (measurement tools for information exposure).

- It was determined that Adam Dunn could participate in full for the purposes of this meeting. The participants of the meeting would be informed that the University of Sydney had been commissioned to do this work for WHO. Participants would be informed that Adam Dunn would not be part of the consensus driving during the closing session of the meeting.

Tim Mackey declared ownership interest and employment in the company S-3 Research LLC. He is its CEO with an annual salary of approximately US$ 80 000.

- It was determined that Tim Mackey's work in relation to S-3 Research LCC focuses on counterfeit medicines online and does not pose a conflict to the objectives of this meeting. He could participate in full for the objectives of this meeting.

Lucie Bucci declared employment by the Immunize Canada coalition/Canadian Public Health Association (CPHA), a national coalition whose mandate is to promote, educate and raise awareness about the benefits of immunization and the usage of vaccines as recommended by the National Advisory Committee on Immunization (NACI). There is an advocacy component to this position where the benefits of immunization are strongly supported. Immunize Canada received ~ 5.3 million Canadian dollars from Seqirus, Merck Canada, Pfizer Canada, GSK Canada for patient advocacy work. As staff of CPHA, Lucie Bucci is also a member of the Elimination of Cervical Cancer in Canada Advisory Committee coordinated by the Canadian Partnership Against Cancer (CPAC). She is also the principal investigator on two grants from Canadian Institutes of Health Research (CIHR) of 200 000 and 1 000 000 Canadian dollars, which are not related to the infodemic.

- It was determined that the beneficiary of the mentioned grants was the CPHA, and the funded work was directed at vaccine communication to patients and confidence of patients in vaccines. This work did not pose a conflict to the objectives of this meeting. Lucie Bucci could participate in full for the objectives of this meeting.

Benjamin O'Neill declared past employment with a humanitarian organization, Samaritan's Purse International Relief, which concluded in July 2021.

- It was determined that the former employer is a CSO with a humanitarian aid organization. It did not pose a conflict to the objectives of this meeting. Benjamin O'Neill could participate in full for the objectives of this meeting.

Claire Wardle declared that she was Executive Director/employed by non-profit organization First Draft, which had received US$ 150 000 from Google, and the project had been completed. Claire gave testimonial evidence to the United Kingdom, Canadian and Singapore governments about misinformation. She had also received US$ 100 000 from WHO to perform testing of an SMS-based inoculation project against health misinformation.

- It was determined that Claire Wardle could participate in full for the objectives of this meeting. It was determined that FirstDraft is a non-profit organization. The participants at the meeting would be informed that FirstDraft had been commissioned to do this work for WHO. Participants would be informed that Claire Wardle would not be part of the consensus driving during the closing session of the meeting.

Elena Pallari declared funding from the Medical Research Council, KCL (Urology Foundation) to participate in conferences and training.

- It was determined that Elena Pallari could participate in full for the objectives of this meeting. It was determined that she had received conference stipends, training fees and publication fee support funding from non-private sector entities.

Noel Brewer declared receiving paid advisory services to WHO and US CDC (US$ 10 000–50 000 each), Merck (US$ 10 000–50 000), Novartis (<US$ 10 000).

- It was determined that Noel Brewer could participate in full for the objectives of this meeting. It was determined that he had received advisory fees from the private sector. Participants would be informed that Noel Brewer would not be part of the consensus driving during the closing session of the meeting.

Ian Brooks declared that his university received research funding of US$ 90 000 from the Pan American Health Organization, and also declared employment by the University of Illinois.

- It was determined that Ian Brooks could participate in full for the objectives of this meeting. The funding was received by the University of Illinois Urbana-Champaign. Participants would be informed that the University received the funds for a research project and that Ian Brooks would not be part of the consensus driving during the closing session of the meeting.

Stefan Mandic-Rajcevic declared receiving consultancy fees of €1300 from the "EURO Health Group" research consortium.

- It was determined that Stefan Mandic-Rajcevic could participate in full for the objectives of this meeting. The fee received was a small amount.

Jon Roozenbeek declared that his university received research funding of a total amount of US$ 2 million from NATO StratCOM CoE, Google Jigsaw, Whats App, British academy, ESRC, United Kingdom Cabinet Office and EU Horizon 2020.

- It was determined that Jon Roozenbeek could participate in full for the objectives of this meeting. The funding was received by the University of Cambridge. Participants would be informed that Jon Roozenbeek would not be part of the consensus driving during the closing session of the meeting.

Sander van der Linden has declared consulting for and receiving research funding from Google (US$ 250 000), Facebook/WhatsApp (GB£ 170 000), Edelman (GB£ 5000), the government of the United Kingdom (GB£ 500 000), the US government (US$ 0) and the EU Commission (€275 000) for research on infodemics and misinformation.

- It was determined that Sander van der Linden could participate in full for the objectives of this meeting. The funding was received by the University of Cambridge. Participants would be informed that Sander van der Linden would not be part of the consensus driving during the closing session of the meeting.

Anatoliy Gruzd declared that Ryerson University had received US$ 160 000 research grant from the Canadian Institutes of Health Research (CIHR). The project is ongoing.

- It was determined that Anatoliy Gruzd could participate in full for the objectives of this meeting. The funding was received by the University from a public research funding institute.

Aleksandar Stevanovic declared that he is a researcher on a project related to vaccine hesitancy, for which he has received €800, the project is ongoing, paid for by Euro Health Group A/S – Denmark.

- It was determined that Aleksandar Stevanovic could participate in full for the objectives of this meeting. The fee received was a small amount.

Bruce Gellin declared that in his past role as President, Global Immunization at the Sabin Vaccine Instate, he organized a meeting on vaccination hesitancy (Sabin–Aspen Vaccine Science and Policy Group) where vaccine misinformation was among the meeting's (and the subsequent report's) theme *https://www.sabin.org/updates/ events/meeting-challenge-vaccination-hesitancy-and-acceptance*

- It was determined that Bruce Gellin could participate in full for the objectives of this meeting. The declared activity did not pose a conflict with the objectives of the meeting and it had concluded.

Peter Benjamin declared that he is the founder and CEO of HealthEnabled, which received US$ 50 000 from Gavi, The Vaccine Alliance to do digital social listening. The project ceased in June 2021.

- It was determined that Peter Benjamin could participate in full for the objectives of this meeting. The funding was received from a technical cooperation partner and the project had concluded.

Jennifer Nilsen declared employment with Harvard University, working in the field of medical misinformation.

- It was determined that Jennifer Nilsen could participate in full for the objectives of this meeting.

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