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Perspectives of scholars on the origin, spread and consequences of COVID-19 are diverse but not polarized

Prakash Kumar Paudel[1✉], Rabin Bastola[2], Sanford D. Eigenbrode[3], Amaël Borzée[4], Santosh Thapa[5], Dana Rad[6], Jayaraj Vijaya Kumaran[7], Suganthi Appalasamy[8], Mohammad Mosharraf Hossain[9], Anirban Ash[10], Raju Adhikari[11], Roshan Babu Ojha[12], Shreeya Manandhar[1], Bhagawati Kunwar[13], Fikty Aprilinayati[14], Ambarish Pokhrel[15], Bharat Raj Poudel[16], Shanta Dhakal[17], Obeta M. Uchejeso[18], Susanta Kumar Ghosh[19], Nilanchal Patel[20] & Subodh Adhikari[3]

The coronavirus disease 2019 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus 2, has devastated every sphere of human society. Governments around the world implemented unprecedented policies designed to slow the spread of the disease and assistance to cope with its impacts. Such policies, however, are short-term and debates have ensued about what broader policies are needed in the post-COVID-19 era to ensure societies are better prepared for future pandemics. Public opinion concerning COVID-19 and the post-COVID-19 era is diverse, and the patterns in opinion are not well documented. Here we synthesized the opinions of 3731 research scholars throughout the world based on a survey. The highest consensus among respondents concerned the need for improving public health infrastructure and delivering economic support, whereas agreement concerning ecological aspects was low. The survey revealed three dimensions of thinking about COVID-19. The first dimension relates to public health and has widespread support. The second dimension relates to science-led policy development focusing on social justice and environmental governance, covering components of both ecology and economy. The third dimension covers the role of nature conservation in reducing the risk of pandemics. Although opinions differed with age, country of citizenship, and level of education, there is strong agreement on the need for global health equity and science-led public policy.

A full list of author affiliations appears at the end of the paper.

Introduction

The coronavirus disease 2019 (COVID-19) has shaken the foundation of global economic, social, and health systems (Akhtaruzzaman` et al., 2020; Josephson et al., 2021; Shamasunder et al., 2020). The disease is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Bolourian and Mojtahedi, 2020), one of several forms of the severe acute respiratory syndrome coronavirus (SARS-CoV) (Wu et al., 2020). The World Health Organization (WHO) declared the SARS-CoV-2 outbreak a public health emergency of international concern on 30 January 2020 to intensify the global preparedness, and later declared it a global pandemic on 11 March 2020 (WHO, 2020). The disease rapidly spread from China throughout the world, with 211 million cases and 4.43 million deaths worldwide as of August 22, 2021 (WHO, 2021). Governments have been implementing a range of stringent measures (e.g. full or partial lockdown) to limit the spread of the disease (Karnon, 2020; Ren, 2020; Sharov, 2020; Stiegler and Bouchard, 2020; Vaughan, 2020). Consequently, many activities have been brought to a pause around the globe, resulting in a plummeting global economic growth from a forecasted 3.3% to −3.0% (Ibn-Mohammed et al., 2021). Although public health and infectious disease experts have previously warned about the possibility of new pandemics (Castillo-Chavez et al., 2015; Farrar and Piot, 2014; Pang, 2016; Yen et al., 2014), a pandemic on such a scale and extent was unanticipated, and it has spurred debates about how the coronavirus will affect the world from different philosophical viewpoints (Kissinger, 2020; Schwab and Malleret, 2020; Sharfuddin, 2020).

COVID-19 and other similar zoonotic diseases (e.g., SARS-CoV, MERS-CoV, Ebola) originate and spread when the pathogens overcome barriers to moving from non-human hosts (e.g., wild and domestic animals) to infect humans (Farrar and Piot, 2014; Maffioli, 2020; Moon et al., 2015; Peiris et al., 2004; Plowright et al., 2017). The severity of the impact of such diseases depends on how easily they spread (Leung, 2021), how serious the illness the diseases may cause (Borges do Nascimento et al., 2020), and how social, cultural, economic, and political systems respond to the diseases (De Sadeleer and Godfroid, 2020; Weible et al., 2020). There is a growing recognition that addressing COVID-19 and future pandemics requires a new approach (Bontempi et al., 2020; Kissinger, 2020; Schwab and Malleret, 2020; Sharfuddin, 2020). Reaching a broad consensus about this new approach is warranted but difficult to achieve due to diverse perspectives on how and why COVID-19 impacted on such an unprecedented scale and what measures are needed to contain such pandemics in the future (Bontempi et al., 2020; Yan et al., 2020).

Some posit that increased anthropogenic activities and subsequent biodiversity loss facilitate the emergence and spread of infectious zoonoses to the human population through various pathways (Gottdenker et al., 2014; Myers et al., 2013; Turcios-Casco and Cazzolla Gatti, 2020). Supporters of this position argue that conservation of natural ecosystems is requisite to reducing the risk of future pandemics like COVID-19 (Turcios-Casco and Cazzolla Gatti, 2020). Some advocate stringent actions, including a complete ban on wildlife trade, to reduce risks of zoonotic pandemics (Benítez-López et al., 2019; Borzée et al., 2020).

In addition, some assert that economic inequality and existing production and consumption patterns around the globe aggravated the impacts of COVID-19 (Stevano et al., 2021). They argue that socio-economic inequality is associated with neoliberalism, which benefits private markets and corporate wealth, reduces public expenditure on health infrastructure, and makes it harder for poor people to get good health care, facilities the spread and impact of the disease (van Barneveld et al., 2020). Others, in contrast, view this problem purely from a health perspective and argue that a strong public health system, including global surveillance, is needed to save lives and avoid future pandemics (Anderson et al., 2020; Cruz et al., 2021; De Ceukelaire and Bodini, 2020). Some also believe that pandemics are regular phenomena that erupt, proceed, and subside over time, with differing scales and extents of impact (Davies, 2020). They argue that pervasive human behavioral change is needed to cope with pandemics, rather than stringent policy measures that will further jeopardize the livelihoods of already impoverished populations (Smith and Gibson, 2020). Poor and marginalized communities are disproportionately affected by pandemics, but they benefit less from responses due to neglect of local needs and characteristics (e.g., social, ecological, economic condition, etc.). Addressing this disparity requires people-centric policy responses (Dry and Leach, 2010). Scholars within public health, and similar fields often link three domains—animals, people, and the environment—to achieve a sustainable approach to public health (King, 2013). The concept of linking these domains depends upon an integrated, holistic and system-based approach to improve health in all three domains and it is often referred as "One Health" approach (King, 2013; Murtaugh et al., 2017; Zinsstag et al., 2020). The concept gained greater acceptance among health professionals with increases in emerging human infectious diseases, but has remained less familiar to wider audiences.

While there is widespread acknowledgement of the need for a paradigm shift in policies to contend with such public health crises in the future, there is much debate about what is required, reflecting diverse philosophical and ideological viewpoints and experiences (Bontempi et al., 2020; Kissinger, 2020; Schwab and Malleret, 2020; Sharfuddin, 2020; Yan et al., 2020). Since all recent pandemics have been caused by zoonotic viruses, vulnerability to future events depends on interactions between animals and humans (Bezerra-Santos et al., 2021; Plowright et al., 2017; Reaser et al., 2021), including social, economic, and health factors that greatly affect the spread of pathogens and their impact on the human population (Anderson et al., 2020; De Ceukelaire and Bodini, 2020; De Sadeleer and Godfroid, 2020; Shamasunder et al., 2020; Stevano et al., 2021). In this context, viewpoints about COVID-19 are driven by diverse perspectives. This article seeks to examine the pattern of these perspectives empirically, by using responses from researchers globally to a survey of prompts related to the origin and spread of COVID-19, ways to avoid it, and expectations in the post-COVID-19 world. This study aims to answer the following research questions:

1. *What is the level of agreement among researchers about origin and spread of COVID-19, its avoidance and expectation in the post COVID-19 from the social, economic, health and ecological views?*
2. *Are there distinct patterns of thinking among the researchers globally about the COVID-19?*
3. *Which factors (e.g., gender, age, job experience, education level, economies of respondents' country of residence, etc.) are associated with views related to expectation in the post COVID-19?*

Theoretical framework. COVID-19 is potentially the most severe global health crisis to date, engendering debates on its origin, spread and consequences by researchers throughout the world. Many researchers have provided a detailed discussion of COVID-19 from ecological (Borzée et al., 2020; De Sadeleer and Godfroid, 2020; Gottdenker et al., 2014), socio-economic (Blundell et al., 2020; Dang et al., 2020), public health (Castillo-Chavez et al., 2015; Summers et al., 2020) and political (Moon et al., 2015; Sharfuddin, 2020) standpoints. However, such discussions are

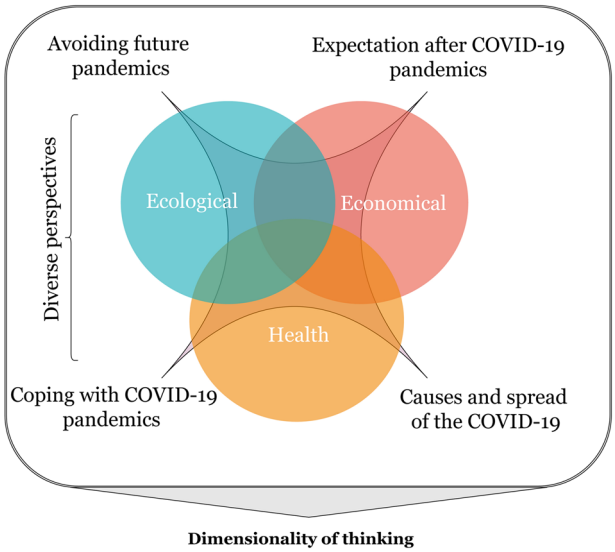

Fig. 1 Conceptual framework of the dimensionality of thinking about COVID-19 perspective.

limited to certain contexts and/or research disciplines and do not provide dimensionality of thinking of all researchers. While public opinion and debates are historically shaped by the mass media with setting agendas, framing and priming the content (Entman, 1993), the rapid evolution of social media and other online tools have transformed the traditional landscape of media communication (Moy and Bosch, 2013). We focus this survey among researchers who are known to have a high-level knowledge and skills in their specific research area (Bland and Schmitz, 1986). As shown in Fig. 1, we sought respondents' levels of agreement to the prompts that span various viewpoints (e.g., economic, health, ecological, etc.) about past, present and future of COVID-19. Understanding these dimensions of perspectives may serve as a steppingstone for informing policy makers about possible strategies to contain such pandemics in future.

Methods

Survey design and sampling. We surveyed perceptions of the scientific community about the past, present, and future of COVID-19 using an online questionnaire with the aid of a proprietary software SoGoSurvey (SoGo Survey Inc., Herndon, VA; www.sogosurvey.com). We obtained a list of researchers and their email addresses from Elsevier's Scopus database, covering at least 25,000 researchers from the following disciplines: social sciences, physical sciences, life sciences and health sciences. The Scopus database allowed us to harvest the email addresses of corresponding authors by affiliation (countries) and subject area categories. We emailed 102,560 researchers across the globe, requesting that they respond to our survey. The survey was administered between June 5 and September 5, 2020. Some authors were also involved in the distribution of the survey in their professional networks via emails and social media (e.g., Facebook, Twitter, LinkedIn, WhatsApp), ensuring that the recipient is a researcher.

Questionnaire. The questionnaire (accessible at https://doi.org/10.7910/DVN/WNLSLV) comprised three parts for a total of 34 questions. The first part (questions 1–8) gathered demographic data about respondents including their age, gender, educational background (e.g., disciplines and level), nationality, and employment status. The second part (questions 9–13) included five questions related to the respondents' COVID-19 experiences, such as direct/indirect impacts, including new opportunities incurred by lockdown and other unexpected situations. This included one question with seven statements about the effects of the COVID lockdown, both positive and negative, and allowed participants to select any that applied for them. The final part included 20 questions, 14–33 inclusive, that were focal prompts of this survey and designed to assess respondents' views on four broad areas: "causes and spread of the COVID-19", "coping with the COVID-19 pandemic", "avoiding future pandemics" and "expectations after COVID-19". Each area included five prompts to which respondents indicated their level of agreement on a seven-point Likert scale (e.g., strongly disagree, disagree, slightly disagree, neutral, slightly agree, agree, strongly agree). There is a final question (question 34), asking respondents whether COVID-19 is an environmental crisis, with three response levels (agree, partially, and no).

Quality control. We designed the survey questions to be both concise and clear. We aimed at making each question as easy as possible, requiring simple checkboxes for levels of agreement with prompts and not requiring comments or further explanation. We then piloted the survey in the SoGoSurvey platform for its understandability among our colleagues ($n = 14$), modifying the prompts based on feedback we received.

Ethics. This survey was conducted with approval from, and in accordance with, the Kathmandu Institute of Applied Sciences Research Ethics Committee (decision letter number: REC2020-01). The survey included a first page on which we explained its objectives, clarified that the obtained data would remain anonymous and that the survey would be reported only in aggregate in the form of scientific reports (e.g., journal articles, research communication, policy notes, etc.). We then requested the respondents to confirm their consent by checking a box stating that they agree to participate in the survey.

Data analysis. We computed the descriptive statistics of age and work experience (mean ± standard deviation). Gender, citizenship, academic degree, employment status and COVID-19 experience were reported as percentages. We calculated the frequency distribution of Likert responses of 20 prompts (9–13) where we asked respondents to specify their revel of agreement to four broad areas ("causes and spread of the COVID-19", "coping with the COVID-19 pandemic", "avoiding future pandemics" and "expectations after COVID-19") in seven points: (1) strongly disagree, (2) disagree, (3) slightly disagree, (4) neutral, (5) slightly agree, (6) agree and (7) strongly agree. We then computed an agreement score as implemented by Van der Eijk (2001) (Van der Eijk, 2001) for each prompt that ranges from 1 to −1, where 1 denotes all respondents selecting either 'strongly agree' or 'strongly disagree', 0 denotes a uniform distribution of responses across all 7 Likert score, and −1 denotes half the respondents selecting 'strongly agree' and remaining half on 'strongly disagree'.

In order to identify key dimensions of variability on 20 prompts described above about four broad areas ("causes and spread", "coping with COVID-19", "avoiding COVID-19", and "expectations after COVID-19" of COVID-19), we examined the dimensionality of thinking about COVID-19 using an exploratory factor analysis (EFA) of our Likert scale response data (Preacher and MacCallum, 2003). The Kaiser–Meyer–Olkin (KMO) measure acceptable (Hutcheson and Sofroniou, 1999) (0.83) suggested sampling adequacy for the analysis (KMO values between 0.8 and 1 are considered acceptable). Bartlett's test [$\chi^2(496) = 16{,}786.99$; $p < 0.0001$] indicated that correlations

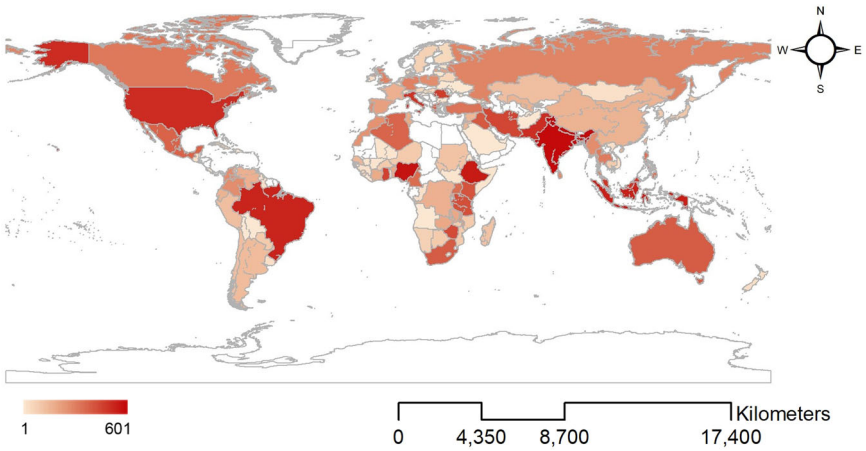

Fig. 2 Geographical distribution of respondents by country of citizenship. The darker the color the higher number of respondents.

between Likert scale responses were sufficiently large. A parallel analysis and scree plot examination suggested three overall factors, and a 3-factor model was tested based on theory (Cattell, 1966). Parallel analysis selects factors with eigenvalues larger than that of random data (Horn, 1965), whereas the scree plot involves plotting the eigenvalues in a decreasing order against the number of extracted dimensions (factors), where dimensions to the left of an 'elbow' are retained as a significant factor (Cattell, 1966). Maximum likelihood estimation was used with direct oblimin rotation because of the expected factor correlation (Costello and Osborne, 2005). After testing, 12 out of 20 prompts were selected using the criterion that loadings must be >0.500. This model achieved a simple structure with each item loading on one factor. The model indicated a good fit standardized root mean squared error approximation (RMSEA = 0.06) and standardized root mean residual (SRMR = 0.040) (Fabrigar et al., 1999; Hu and Bentler, 1999), suggesting an acceptable fit to the 3-factor model.

We used multinomial logistic regression to analyze the relationship between each of the Likert scale responses about "expectation after COVID-19" with respondents' demographic variables, COVID-19 experience and perception (e.g., gender, age, academic level, employment status, job experience, economic ranking of respondents' country of citizenship, COVID as an environmental issue) (Supplementary Table 1). For clarity for this analysis, we used an aggregate 3-point Likert scale "disagree" (strongly disagree, slightly disagree, or disagree), neutral, and agree (strongly agree, slightly agree, or disagree). Multinomial logistic regression is a simple extension of binary logistic regression that allows for more than two categories of the dependent or outcome variable. Here, we developed 10 hierarchical models, with a full model consisting of 10 variables (described above). The other 9 models are nested sub-models dropping one variable (Supplementary Table 3). All 10 models were compared by X^2 tests. The Akaike information criterion (AIC) was used to determine the best-fitting model by evaluating model parsimony (i.e., the best goodness-of-fit combined with the fewest latent variables). The model with the lowest AIC suggests the best fit.

All analyses were carried out in R v1.2.1335 (R Core Team, 2018) using various packages: 'pastecs' (Grosjean et al., 2018) for descriptive statistics; 'ggalluvial', 'ggplot2' (Wickham and Chang, 2008) and 'likert' (Bryer et al., 2016), including Tableau (version 2019.1) for data visualization; 'kruskal.test' of R base, and 'agrmt' to carry out agreement test on responses of Likert type statements (Ruedin, 2016). For multinomial regression and computing odd ratios, we used the R-packages "ordinal", "lmtest", "VGAM" and "nnet".

We are aware of possible caveats, induced by sample size ($n = 3731$) and its adequacy in terms of respondent's academic background and countries of origin. We are confident that our sample size is adequate for our conclusions, and any biases, if induced, are minimal. First, we focused our survey to published research scholars and purposefully selected authors from all countries and disciplines (25,000 authors for each of social sciences, health sciences, physical sciences and life sciences). Our respondents were from 131 countries, and the top ten countries of respondents were India (16%), Nigeria (4%), Bangladesh (4%), Ethiopia (4%), Indonesia (3%), Brazil (3%), United States (3%), Pakistan (2%), Italy (2%), Malaysia (2%), and Nepal (2%). Although the response frequencies were not proportionate to the populations of surveyed academic community among countries, responses cover all major economies across continents. Since we did not analyze the data at the country level and present the results in aggregate, our data analysis strategy overcomes the effects of sample sizes, if any.

Results

Demographic characteristics. A total of 3789 individuals participated in the COVID-19 global survey, but 3731 respondents were included in this analysis after removing 58 respondents with identical email addresses. The respondents were from 131 countries across the world and the number of respondents per country ranged from 1 (20 countries) to 601 (India) (Fig. 2).

Sixty-eight percent of respondents were male, giving an overall male to female ratio of 2.1. Respondents' work experience ranged from 0 to 50 years with a mean of 13.3 ± 11.4 years and a median of 10 years. The mean age for respondents was 40.9 ± 12.2 years. Most respondents were working full time (74.0%), followed by unemployed (15.3%) (e.g., students or homemakers), working part-time (5.9%), self-employed (2.7%), and retired (2.2%). A majority of respondents had PhD degrees (66.0%), followed by university graduates (26.0%) and undergraduates (8.0%). In terms of sex our sample is representative of our population as women account only 30.0% researchers globally (UNESCO, 2019).

COVID-19 experience. Most participants (78%) indicated that COVID-19 had direct or indirect effects on them, which included 'very affected' (13%), 'slightly affected' (28%), and 'affected' (37%). Among the remaining respondents, 15% indicated they were 'not affected' and 7% were neutral in their response.

Among the seven possible statements about respondents' experiences during COVID-19 related restrictions that comprised the second part of the survey, the most common response was "I

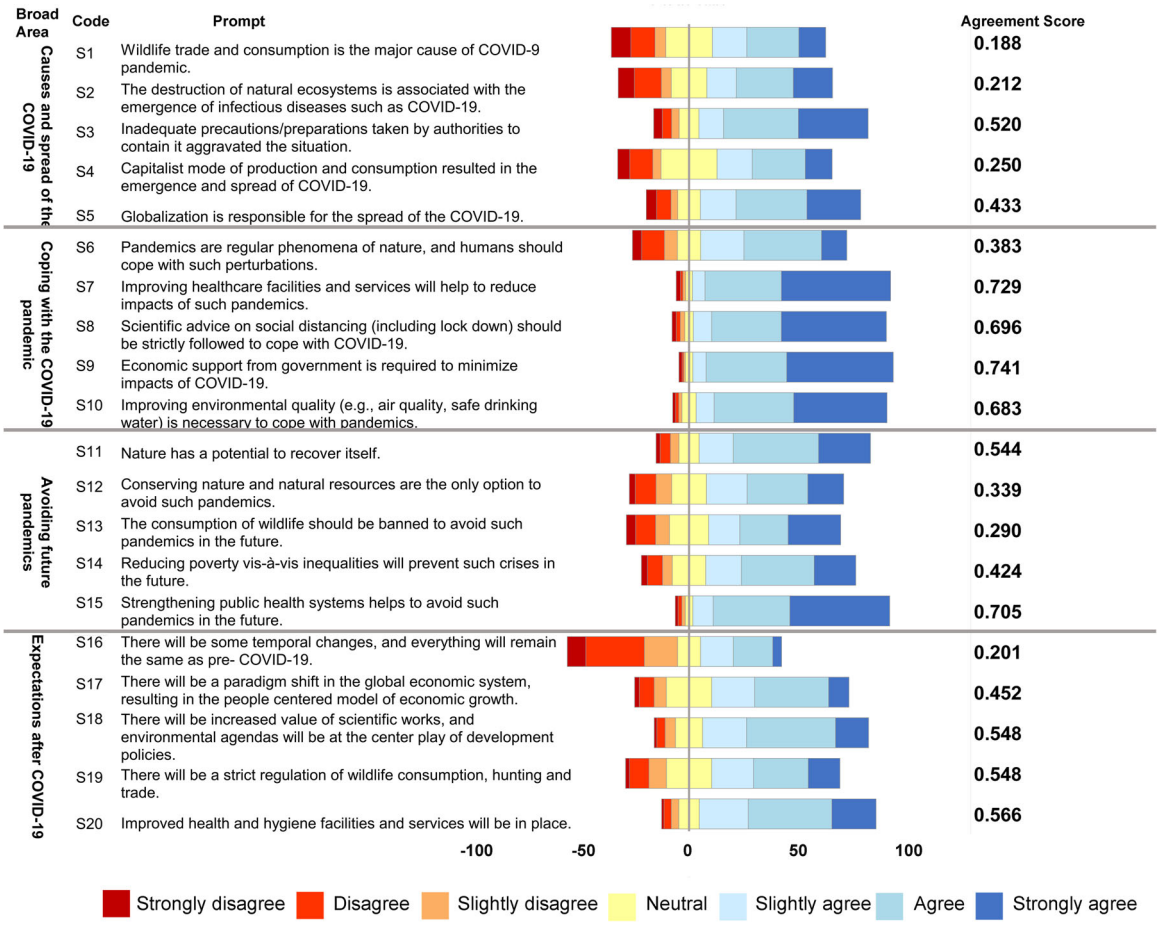

Fig. 3 The views of participants about (a) cause and spread of COVID-19, (b) coping with COVID-19 pandemic, (c) avoiding future pandemics, and (d) expectation after COVID-19 to the seven-point Likert score. The distribution of responses is shown for each survey item. The agreement score provided next to the bar diagram ranges from −1 to −1, where 1 denotes a complete agreement on a prompt; 0 denotes equal agreement on all categories, and −1 denotes complete lack of agreement. The details of scores by economies of respondents' countries of citizenship are provided in Supplementary Table 2.

have/had quality time with family" (61%), followed by "I am worried about the future uncertainties" (56%), "I am enjoying working from my comfort zone" (45%), "I enjoyed calmness, better air quality and beautiful landscape" (41%), "I am having a difficult time due to isolation from family/friends" (28%), "I have/had most appropriate time to meditate" (25%), and "I enjoyed sightings of wildlife (e.g., birds, butterflies) and their sounds frequently" (23%).

Views on COVID-19. In the third part of our survey, respondents indicated their levels of agreement with the 20 Likert items that covered four areas concerning COVID-19 (Fig. 3). Overall, the highest level of consensus among participants was agreement with "economic support from government is required to minimize impacts of COVID-19" (S9). The second and third strongest consensuses were in agreement with "improving healthcare facilities and services would help to reduce impacts of such pandemics" (S7) and "strengthening public health systems (S15) would help to avoid such pandemics in the future". There was more agreement with prompts related to public health in all major areas of the investigation than with prompts relating to ecology (Fig. 3). The greatest agreement about the causes and spread of COVID-19 was that it was related to poor preparedness to contain it (S3) (Fig. 3). The respondents expected a "new normal", in which the most anticipated change included (a) improved health and hygiene facilities (S20), (b) increased value of scientific work (S18), and (c) stricter regulation of wildlife trade (S19) (Fig. 3). The prompt with the least agreement was "wildlife trade and consumption are the major cause of COVID-19 pandemic".

Dimensions of the COVID-19 response. The exploratory factor analysis (EFA) of the 20 prompts retained 12 prompts with loading scores above a threshold of 0.500 that could be placed within three factors, each suggesting a specific dimension of perspective: (a) strengthening public health (e.g., health infrastructure, environmental quality) and safety protocol, (b) enforcing evidence-based actions with better environmental policies and sanitation, and (c) maintaining ecosystem and enforcing strict wildlife trade regulation (Table 1).

Except for prompt S15, the first dimension covered prompts on "coping with the COVID-19 pandemic", with the highest loading on "improving healthcare facilities" (S7), followed by the need for economic support (S9) and improvement of environmental quality (S10). The second dimension entirely covered four prompts related to "expectations after the COVID-19", where the value of scientific work (S18) and health care facilities (S20) had the highest factor loadings. The third dimension covered prompts related to "causes and spread of COVID-19" (S2, S1) and "avoiding future pandemics" (S13) and was related to the ecological perspective (Table 1). Thus, the first dimension included respondents who prioritize public health with health equity in mind (public health perspective). The second dimension included participants who expect a transformative post-COVID-

Table 1 A factor loading of COVID-19 prompts (prompts 14–33 with loading greater than 0.500) about "causes and spread of the COVID-19", "coping with the COVID-19 pandemic", "avoiding future pandemics" and "expectations after COVID-19 based on exploratory factor analysis.

Factor (dimension)	Code	Prompt	Loading
1	S7	Improving healthcare facilities and services will help to reduce impacts of such pandemics.	0.72
	S9	Economic support from government is required to minimize impacts of COVID-19.	0.67
	S10	Improving environmental quality (e.g., air quality, safe drinking water) is necessary to cope with pandemics.	0.53
	S8	Scientific advice on social distancing (including lockdown) should be strictly followed to cope with COVID-19.	0.52
	S15	Strengthening public health systems helps to avoid such pandemics in the future.	0.52
2	S18	There will be an increased value of scientific works, and environmental agendas will be at the center play of development policies.	0.76
	S20	Improved health and hygiene facilities and services will be in place.	0.69
	S19	There will be strict regulation of wildlife consumption, hunting and trade.	0.67
	S17	There will be a paradigm shift in the global economic system, resulting in the people-centered model of economic growth.	0.56
3	S2	The destruction of natural ecosystems is associated with the emergence of infectious diseases such as COVID-19.	0.68
	S13	The consumption of wildlife should be banned to avoid such pandemics in the future.	0.57
	S1	Wildlife trade and consumption is the major cause of COVID-19 pandemic.	0.67

19 world where scientific research would be more important in decision making and better environmental hygienic facilities (science-led public policy perspective). The third dimension included participants who believe the spread of COVID-19 stems from the destruction of natural ecosystems and a ban on wildlife consumption is needed to avoid such pandemics (ecosystem-based perspective). The reliability of all three factors was high with 0.75, 0.76, and 0.71 for factors 1, 2, and 3 respectively.

Determinants of the COVID-19 response. The multiple logistic regression assessing the influences of personal information, COVID-19 experiences, and economic status of respondents' country of citizenship (Supplementary Table 4) on responses (e.g., agree, neutral, and disagree) on prompts related to "expectations after COVID-19" showed that males, those who graduated from college and university, and those either slightly affected or unaffected by COVID-19 were less likely to disagree —compared to those who agreed— with the prompt, "There will be some temporal changes, and everything will remain the same as pre- COVID-19" (S16). However, those who had not anticipated the impact of COVID-19 were more likely to disagree with prompt S16 (Supplementary Table 4). Similarly, respondents with high work experience were less likely to be "neutral" to the above prompt as compared with respondents who agreed with it. All respondents except those from high-income countries, those partially affected by COVID-19, and those who anticipated the impact of COVID-19 were less likely to be neutral as compared to those who agreed with S17, "There will be a paradigm shift in the global economic system, resulting in the people-centered model of economic growth".

The participants who were neutral in their response to prompt S18, "There will be the increased value of scientific works, and environmental agendas will be at the center play of development policies", were less likely to be from low-income countries and had "very much anticipation" about the impact of COVID-19 compared with those who agreed with this prompt. The participants whose response was neutral to the prompt, "There will be a strict regulation of wildlife consumption, hunting and trade" (S19), vs. those who agreed with it, were less likely to be from low-income and upper-middle-income countries and did not consider COVID-19 as an environmental problem. Those who disagreed with prompt S19 vs. those who agreed with it were less likely experienced people but more likely older ones (Supplementary Table 4). None of the variables was significantly associated with prompt "Improved health and hygiene facilities and services will be in place" (S20).

Discussion

To the best of our knowledge, this is the first study assessing how the research community views COVID-19 in terms of its origin and spread, ways to avoid it, and expectations for post-COVID-19. We detected the range viewpoints about COVID-19 and how these aligned with researcher backgrounds and demographics.

Area of consensus. The strongest consensus was agreement with prompts related to coping with COVID-19 through (a) increasing economic support (S9), (b) improving health care facilities (S7), (c) strengthening public health systems (S15), and (d) adhering to scientific advice (S8). The highest consensus in agreement with prompt S9 is understandable since COVID-19 pandemic-related constraints caused enormous declines in global economies that disproportionately impacted developing countries (Ibn-Mohammed et al., 2021; Loayza, 2020), particularly affecting working-class people (Davies, 2020; Josephson et al., 2021). Most governments implemented economic support policies later than lockdowns and health policies (Hale et al., 2021), failing to provide timely support for needy populations (Loayza, 2020). Because of limited resources and capabilities (e.g., economic resources, poor public health infrastructure), developing countries had few options (Loayza, 2020; Maffioli, 2020; McKibbin and Fernando, 2021), which may have prompted survey respondents from developing countries to agree with statements that global economic system, globalization, and social and economic inequalities are issues now and in the post-COVID era (Kanitkar, 2020; Maffioli, 2020). The comprehensive support for the health care system and science-based policies are likely influenced by two factors. First, high death rates during COVID-19 peaks has been attributed to collapse of the public health system in many countries (Faggioni et al., 2021; Ferrante et al., 2020). Some nations (e.g., Taiwan, New Zealand, Singapore) successfully responded to COVID-19 and brought it under-control, because these countries already had a good public health infrastructure and a dedicated national public health agency to implement science-based policies (Lee and Lee, 2020; Summers et al., 2020). Second, failure to control a rapid spread and a surge of human death in the developed countries appear to be, to some extent, related to health inequities within those countries (Gaynor and

Wilson, 2020; Shadmi et al., 2020), ignorance, and science denial by political leaders (Ren, 2020).

The prompt "Wildlife trade and consumption is the major cause of COVID-19 pandemic" received the least support from respondents, and other prompts related to ecological dimension were also not well supported. Those who agreed with prompts concerning the ecological aspects of COVID-19 were mostly from high-income countries, university graduates, or both, consistent with previous studies showing that levels of concern about the environment are positively correlated with the economic status of countries (Franzen and Vogl, 2013; Gelissen, 2007) and levels of education (Aminrad et al., 2011). Such an environmentally conscious attitude takes time to develop and depends on the quality of environmental education received (Bradley et al., 1999; Ramsey and Rickson, 1976).

The multinomial logistic regression analysis detected the impact of demographic factors on respondents' perceptions on some response on prompts. We found that males were more likely to agree than females with the prompt, "There will be some temporal changes, and everything will remain the same as pre-COVID-19" (S16). This may be related to men's tendency to perceive fewer negative impacts of environmental crises (e.g., climate change) (Poortinga et al., 2019), but it warrants further investigation. Respondents from high income and middle-high income countries, those highly educated, experienced, and senior showed greater support for the prompt, "The consumption of wildlife should be banned to avoid such pandemics in the future" (S13). Such support for banning wildlife consumption perhaps reflects a call for direct intervention that would reduce pathogen spillover from animals to people (Plowright et al., 2017), although broader actions such as limiting land-use change have been advocated to contain the emergence of zoonotic diseases (Plowright et al., 2021).

Respondents from low-and-middle-income countries showed strong support for the prompt, "There will be an increased value of scientific works, and environmental agendas will be at the center play of development policies", which may be related to the severity of environmental problems (e.g., water pollution, sanitation) in these countries, aggravating the impacts of COVID-19 (Cruz et al., 2021; Josephson et al., 2021; Shamasunder et al., 2020; Stiegler and Bouchard, 2020; van Barneveld et al., 2020). We did not find an association between any demographic variables and the prompt, "Improved health and hygiene facilities and services will be in place", reflecting the widespread support for this prompt from all regions, academic levels, and age groups (Cruz et al., 2021; Loayza, 2020; Shadmi et al., 2020; Shamasunder et al., 2020).

The pandemic has affected almost all walks of life in society, but the severity of impacts was disproportionately high among minorities, poor, and disadvantaged communities (Gaynor and Wilson, 2020). For our respondents, taken here as representative of the scientific research community, COVID-19 provided new opportunities or advantages (e.g., time spent with family) but also uncertainty. For example, 61% of respondents agreed with the statement, "I have/had quality time with family", and 56% with, "I am worried about the future uncertainties". The lockdown and/or self-imposed "work from home" gave an opportunity to be with family members for some time and helped increase closeness, reconnection, better communication, deeper personal relationships (Every-Palmer et al., 2020) and to appreciate surroundings, with more sighting of wildlife (Manenti et al., 2020; Rutz et al., 2020). On the other hand, restricted movements and prolonged staying at home often have negative psychological effects (Brooks et al., 2020; Chong et al., 2004; Grover et al., 2020; Rania and Coppola, 2021).

Diverse but not polarized views. We noted diverse viewpoints about how COVID-19 unfolded as a global crisis, why it spread on such a scale, and what post-pandemic transformations are required to cope with similar future crisis. Our results, based on exploratory factor analysis, will contribute to ongoing efforts to understand and respond to COVID-19 (Kissinger, 2020; Leach et al., 2021; Wasserman et al., 2020).

We confirmed that viewpoints about COVID-19 broadly fall within three dimensions, each representing a unique domain of thinking about COVID-19. The first dimension (strengthening public health) relates to improving health care facilities, strengthening public health systems, improving environmental quality, providing economic support, and integrating scientific advice to avoid and cope with the pandemic, consistent with fundamental elements of health equity perspectives (Shadmi et al., 2020). COVID-19 has affected vulnerable populations disproportionately across the world and in countries with poor public health infrastructure (Blundell et al., 2020; Dang et al., 2020; Galea, 2020; Howard et al., 2017; Iles and Montenegro de Wit, 2020; Kirby, 2020; Shadmi et al., 2020). A proactive public policy supported by scientific evidence is urgently needed to cope with the COVID-19 pandemic and similar global health crises. In both developed and developing countries the COVID-19 crises was exacerbated by politics, with some leaders downplaying the science for political expediency (Gonsalves and Yamey, 2020). For example, the early ignorance by authorities in countries like the United States and Italy resulted in the loss of an opportunity to contain COVID-19 (Haffajee and Mello, 2020; Goumenou et al., 2020). The same occurred in India where the health crisis during the second wave was devastating, but preventable (Lancet, 2021).

The second dimension (science-led public policy) relates to post-COVID-19 expectations for science-informed public policies, promoting health equity, social justice, and environmental governance. This dimension, like the first (strengthening public health), primarily concerns strategies to minimize and cope with the COVID-19 pandemic. This dimension, however, also relates to future strategies in the post-COVID-19 world where respondents call for a paradigm shift ensuring scientific evidence to tackle health inequity to prevent or minimize such pandemics in future (Wang and Tang, 2020).

The third dimension relates to maintaining ecosystem functioning and enforcing strict wildlife trade regulation. This dimension stems from the view that the destruction of natural ecosystems, land-use change, habitat fragmentation, and wildlife hunting and trade increases human–wildlife interfaces and the transmission of zoonotic agents (Keesing et al., 2006; Platto et al., 2021; Plowright et al., 2017; 2021; Reisen, 2010; Terraube and Fernández-Llamazares, 2020). Advocates of this perspective often focus on maintaining ecosystem integrity, and integrating human health into global biodiversity conservation policies (Terraube and Fernández-Llamazares, 2020). Thus, COVID-19 is an opportunity to reflect on the global stresses that humankind as imposed on ecosystems (Zabaniotou, 2020).

Conclusion and the way forward. Epidemics and pandemics remind us of humankinds enduring vulnerability to infectious disease. Our study makes an important contribution to the global COVID-19 debate. Our findings show there is agreement by research scholars around the world in the importance of science-based public policy promoting health equity, environmental governance and social justice. Our results suggested an influence of age, level of education and geographies on agreement with statements concerning causes and remedies for pandemics like COVID-19. Although these views are reflected in the three different dimensions, they are not divided, suggesting an opportunity for a broader agreement. Some variability

in responses to our survey may reflect the academic backgrounds, political ideologies and religious beliefs of respondents, which are beyond the purview of this study (Clark, 1984). Nevertheless, the trends detected in our survey reflect global 'collectivities' because our respondents represent the most informed populations across societies globally. Furthermore, such 'collectivities' are ubiquitous across world due to the rapid expansion of communication tools and human movements (Appadurai, 1996).

Our survey detected strong support for reducing health inequalities and strengthening economic developments, indicating an overarching call by the global research community for better economic justice and access to quality health services. A small proportion of respondents also support ecological perspective (Mansuy, 2020; Roche et al., 2020). Thus, finding a pathway for the better integration of economic and ecological policies provides a win-win situation for the future. While there are already some calls and actions to achieve global sustainability goals (Barbier, 2012; Brondizio et al., 2019; Taylor et al., 2020; UNEP, 1992; United Nations, 2019; United Nations (UN), 1972), COVID-19 has instigated a heightened acknowledgment of green pathways (e.g., biodiversity conservation, green economy, green energy) for a post-pandemic world (Di Marco et al., 2020; Naidoo and Fisher, 2020). The "One Health" approach that gained a foothold in the public health sector similarly links the emergence of zoonotic diseases to environmental degradation. It is important to apply such a perspective in all policy domains (Dye, 2022). However, a small difference in perspectives can impede such integration, requiring an explicit and open debate and involvement of research scholars all around the world for policy advocacy (Gonsalves and Yamey, 2020). China, for example, imposed a ban on wildlife trade following the SARS pandemic in 2012, but relaxed it later (Karesh et al., 2012). It is reasonable to expect that health related disasters facilitated by ongoing global climate change and modifications of natural environments to become more frequent and devastating in future (Bezerra-Santos et al., 2021; Plowright et al., 2021). It is time to continue the conversation to integrate health equity and environmental conservation in public health policies throughout the world.

Data availability

All material is available in the manuscript and supplements.

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Author contributions

PKP was responsible for the conceptualization and design of the study, for conducting data collection and analysis, writing the first draft and consequent refinements. RB contributed for design of the study. RB and SA were responsible for project administration, data collection and review and editing of manuscript. SF supported interpretation of the findings, and reviewing and editing of manuscripts. All authors supported the data collection, and editing and reviewing the manuscript.

Competing interests

The authors declare no competing interests.

Ethical approval

Ethical approval was obtained from the Kathmandu Institute of Applied Sciences Research Ethics Committee (Ref: REC2020-01). The authors assert that all research was performed in accordance with relevant guidelines/regulations.

Informed consent

Before starting the survey, all participants were informed about the overall objectives and aim of the study as well as the ways the data would be used. Informed consent was obtained from all participants.

Additional information

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Correspondence and requests for materials should be addressed to Prakash Kumar Paudel.

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[1]Center for Conservation Biology, Kathmandu Institute of Applied Sciences, Kathmandu, Nepal. [2]Water Engineering and Management, Asian Institute of Technology, Pathum Thani, Thailand. [3]Department of Entomology, Plant Pathology and Nematology, University of Idaho, Idaho, USA. [4]Laboratory of Animal Behaviour and Conservation, College of Biology and the Environment, Nanjing Forestry University, Nanjing, People's Republic of China. [5]Department of Pathology and Immunology, Baylor College of Medicine & Texas Children's Microbiome Center, Texas

Children's Hospital, Houston, TX, USA. [6]Faculty of Educational Sciences, Psychology and Social Sciences, Aurel Vlaicu University of Arad, Arad, Romania. [7]Faculty of Earth Science, Universiti Malaysia Kelantan, UMK Jeli Campus, Kelantan, Malaysia. [8]Institute of Food Security and Sustainable Agriculture (IFSSA), Universiti Malaysia Kelantan, Jeli Campus, Kelantan, Malaysia. [9]Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong, Bangladesh. [10]Department of Zoology, University of Burdwan, West Bangal Burdwan, India. [11]Royal Melbourne Institute of Technology, Melbourne, Australia. [12]National Soil Science Research Center, Nepal Agricultural Research Council, Lalitpur, Nepal. [13]Chubu University, Kasugai, Japan. [14]Faculty of Biology, Universitas Nasional, South Jakarta, Indonesia. [15]Asian Research Center, Kathmandu, Nepal. [16]Queensland University of Technology (QUT), Brisbane, QLD, Australia. [17]Shanti Foundation, Kathmandu, Nepal. [18]Federal School of Medical Laboratory Science, Jos, Nigeria. [19]ICMR–National Institute of Malaria Research, Field Unit, Bengaluru, India. [20]Department of Remote Sensing, Birla Institute of Technology Mesra, Ranchi, India. ✉email: pk.paudel@gmail.com