

RESEARCH ARTICLE

Shifting research priorities in maternal and child health in the COVID-19 pandemic era in India: A renewed focus on systems strengthening

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Abstract

Background

The remarkable progress seen in maternal and child health (MCH) in India over the past two decades has been impacted by the COVID-19 pandemic. We aimed to undertake a rapid assessment to identify key priorities for public health research in MCH in India within the context and aftermath of the COVID-19 pandemic.

Methods

A web-based survey was developed to identify top research priorities in MCH. It consisted of 26 questions on six broad domains: vaccine preventable diseases, outbreak preparedness, primary healthcare integration, maternal health, neonatal health, and infectious diseases. Key stakeholders were invited to participate between September and November 2020. Participants assigned importance on a 5-point Likert scale, and assigned overall ranks to each sub-domain research priority. Descriptive statistics were used to examine Likert scale responses, and a ranking analysis was done to obtain an “average ranking score” and identify the top research priority under each domain.

Results

Amongst the 84 respondents from across 15 Indian states, 37% were public-health researchers, 25% healthcare providers, 20% academic faculty and 13% were policy makers. Most respondents considered conducting systems strengthening research as extremely

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important. The highest ranked research priorities were strengthening the public sector workforce (vaccine preventable diseases), enhancing public-health surveillance networks (outbreak preparedness), nutrition support through community workers (primary care integration), encouraging at least 4–8 antenatal visits (maternal health), neonatal resuscitation to reduce birth asphyxia (neonatal health) and screening and treatment of tuberculosis (infectious diseases). Common themes identified through open-ended questions primarily included systems strengthening priorities across domains.

Conclusions

The overall focus for research priorities in MCH in India during the COVID-19 pandemic is on strengthening existing services and service delivery, rather than novel research. Our results highlight pivotal steps within the roadmap for advancing and sustaining maternal and child health gains during the ongoing COVID-19 pandemic and beyond.

Introduction

Maternal and child health (MCH) outcomes have been key public health issues in developing countries including India. While the past 25 years have witnessed a concerted global effort to improve MCH in low-and-middle-income countries (LMICs), more progress is needed to meet the targets laid out in the Sustainable Development Goals (SDGs). In India, key MCH indicators remain concerning, as evidenced by partially released results from the National Family Health Survey-5 (NFHS-5), which indicate worsening of maternal and child nutrition indicators in several states [1]. There is an urgent need to identify targeted approaches to improve the state of MCH in India.

While MCH programs in India are weighed down by wide inequities [1, 2], these challenges have been amplified by the ongoing COVID-19 pandemic. In addition to the direct effects of the disease, the indirect effects of the pandemic have been devastating. Limitations in the availability of skilled health workers and health system access barriers have led to lower coverage of antenatal and postnatal care services, and routine childhood immunization services, especially in rural India [3, 4]. A recent modelling paper estimated that the disruption and decreased utilization of routine health services and reduced access to food during the pandemic could lead to an estimated 9.8–44.7% increase in under-5 child deaths per month, and an 8.3–38.6% increase in maternal deaths per month in LMIC settings [5].

Health research is an essential tool for improving health outcomes in LMICs [6]. Amidst limited economic and manpower resources, it is critical to direct research towards the most important gaps. Recent global and national exercises to identify research priorities in maternal and child health that were conducted prior to the COVID-19 pandemic, mainly identified priorities that pertained to implementation sciences and innovation [7, 8]. However, no such exercises have been conducted in the context of the COVID-19 pandemic in India, and it is unknown as to which domains of maternal and child health research are perceived to be most impactful in the context of an unprecedented pandemic. A research prioritization exercise using a methodical and inclusive process could thus guide researchers, policy makers and funding agencies in making informed decisions and improving outcomes. We aimed to undertake a rapid assessment to identify key priorities for public health research in MCH in India within the context of the COVID-19 pandemic, by surveying key stakeholders and experts in India.

Methods

Survey questionnaire and design

A survey to assess research needs in MCH was developed by researchers at the Johns Hopkins Maternal and Child Health Center in India and stakeholders at key Indian institutions such as the Public Health Foundation of India, All India Institute of Medical Sciences, Kalyani, Postgraduate Institute of Medical Education and Research, Indian Institute of Technology, Kharagpur and Piramal Swasthya Management and Research Institute. Specific priority research domains were identified through a review of previous survey results [2], and literature on global priorities in maternal newborn and child health. All key stakeholders reviewed the survey and research domains included, and provided input that was incorporated; the final survey was derived by consensus. The following six broad research domains were identified, according to the principles of thematic analysis: vaccine preventable diseases, outbreak preparedness, primary healthcare integration, maternal health, neonatal health, and infectious diseases. Since this was a rapid assessment, during the survey development process, we did not undertake iterative processes to generate consensus amongst the contributors. The survey consisted of 26 questions which focused on these six broad domains. Under each domain, participants were requested to assign importance to each sub-domain research priority on a 5-point Likert scale, and assign overall ranks to each sub-domain research priority. Open-ended questions were also included to capture other aspects of research priorities. In each domain, participants had the option to nominate a different research topic not included in the prepared list; these could be ranked by importance in the same manner.

Participants

Key stakeholders working in the field of MCH in India were identified through desk reviews, web-based searches, dissemination in professional networks such as the Indian Association of Preventive and Social Medicine, Indian Public Health Association, Indian Academy of Pediatrics and the Federation of Obstetric and Gynaecological Societies of India, and through collaborators. Stakeholders were identified across various domains of maternal and child health, including those primarily engaged in academia, or specific areas such as health systems, policy and economics, nutrition, and tribal health.

Sampling strategy and sample size determination

Since this was a rapid assessment, we employed convenience sampling, based on a snowball sampling strategy. Further, we did not target any specific sample size; we analyzed all responses that we received until the closure of the online survey.

Dissemination of the survey

The survey was administered online using the software platform Qualtrics (Qualtrics, Provo, UT) between September and November 2020. It was disseminated via email, text messages and social media platforms such as WhatsApp. No personal data were collected, although respondents could choose to share their contact information for future surveys.

Ethical considerations

The study was reviewed by the Johns Hopkins Bloomberg School of Public Health (JHSPH) Institutional Review Board (IRB) which classified the proposed activities as “key informants research”, and therefore determined to be exempt from human subjects research oversight. Consent to participate in the survey was highlighted in the introductory portion of the online survey. Participants were informed that responding to the survey request was voluntary; data

obtained for the survey analysis would remain anonymous, and that completing the survey and submitting it implied that they had consented to participate in the study.

Data analysis

Descriptive statistics, expressed as frequencies and proportions, were used to examine respondent demographics and Likert scale responses. The Likert scale for each sub-domain research priority was analyzed by tabulating responses based on importance level ascribed. A ranking analysis was conducted by three authors (SLP, PB and KM) using weights that were inversely related to the raw rank from the survey, to obtain an “average ranking score”, which helped identify the top research priorities in each research domain [9]. In this method, sub-domain research priorities that were ranked as “1” would receive the largest weight depending on how many sub-domain research priorities were present in each domain. For example, in the vaccine preventable diseases domain, if individuals ranked “Strengthening the public health workforce” as their “1” priority, the weight would be “10” since there were ten sub-domain research priorities listed underneath this domain. If individuals ranked this sub-domain research priority as “2”, then the accompanying weight would be “9”, and so on. The weights were then multiplied by the count of how many respondents ranked the sub-domain research priority as “1”, “2”, and so on. The total sums of all weighted scores were then divided by the total number of respondents for that sub-domain research priority. Thus, the average ranking score of each sub-domain research priority was then calculated using the formula,

$$\text{Average ranking score} = (x_1 w_1 + x_2 w_2 + x_3 w_3 \dots x_n w_n) / \text{Total response count}$$

Where, w = weight of ranked position, and x = response count for each rank.

Responses to the open-ended items were assessed by two authors (SLP and KM). Comments were read independently, and summarized following discussion according to the principles of thematic analysis. The World Health Organization (WHO)’s operational definition for health systems strengthening [10], “any array of initiatives and strategies that improves one or more of the functions of the health system and that leads to better health through improvements in access, coverage, quality, or efficiency” was used to guide the process that categorized responses under the broader theme of “health systems strengthening”.

Results

Participant characteristics

The online survey was completed by 84 respondents (key stakeholders) from 15 states and 2 union territories in India. Male respondents constituted 58%, and professional backgrounds were distributed as follows: public health researchers (37%), healthcare providers (25%), academic teaching faculty (20%) and policy makers (13%). An almost equal number of the respondents belonged to non-governmental organizations/private organizations or governmental organizations, and over 65% had work experience of over 10 years in their primary area of expertise. The most common primary areas of work included child health (20%), infectious diseases (17%), health systems and policy (14%), biostatistics and epidemiology (14%), and maternal health (8%) (Table 1).

Importance of research topics on the Likert scale

Across the six domains identified in the survey, most respondents characterised conducting research on systems strengthening priorities as extremely important (Fig 1). In the vaccine preventable diseases domain, over 50% of the respondents considered enhancing vaccination

Table 1. Characteristics of survey respondents.

Gender	N = 84 (n, %)
Male	49 (58)
Female	35 (42)
Profession	N = 84 (n, %)
Public health researcher	31 (36.9)
Healthcare worker	21 (25.0)
Academia member or teacher	17 (20.2)
Policymaker	11 (13.1)
Other	4 (4.8)
Primary organization type	N = 83 (n, %)†
Non-governmental organization (NGO)/ private organization	31 (37.3)
Government / Ministry of Health	29 (34.9)
University	13 (15.6)
WHO/UN agencies	6 (7.2)
Other	5 (6.0)
Primary area of work	N = 84 (n, %)
Child health	18 (21.4)
Infectious disease	14 (16.6)
Health systems and policy	12 (14.2)
Biostatistics and epidemiology	12 (14.2)
Maternal health	10 (11.9)
Health economics	3 (3.5)
Nutrition	3 (3.5)
Rural/Tribal health outreach	2 (2.3)
Public health planning	2 (2.3)
Environmental and occupational health	2 (2.3)
Clinical research	2 (2.3)
Other	4 (4.7)
Number of years worked in primary area	N = 82 (n, %)††
1–5	11 (13.4)
5–10	16 (19.6)
10–20	27 (32.9)
> 20	28 (34.1)

†Data were missing for 1 participant.

††Data were missing for 2 participants.

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rates among the urban poor, strengthening the public sector workforce and improving vaccination coverage as extremely important. In the outbreak preparedness domain, the proportion who considered the sub-domain research priorities as extremely important ranged from 48% (conducting COVID-19 research for MCH sub-populations) to 76% (enhancing public health surveillance networks). In the primary care integration domain, over 45% of the respondents considered all sub-domain research priorities as extremely important, and 63% felt research on nutrition education support through community health workers was extremely important. In the maternal health domain, systems strengthening was considered extremely important, with 64% considering research on improving facility-based safe delivery outcomes as extremely important. In the neonatal health domain, system strengthening priorities were similarly deemed extremely important, with over 75% considering improving the quality of care during labor and birth, and 67% considering measures to reduce birth asphyxia and improve



Fig 1. Level of importance assigned to individual sub-domain research priorities by respondents across six domains of maternal and child health (n = 84). Legend: In a rapid survey conducted to identify the top priorities in maternal and child health research in India during the COVID-19 pandemic, it was found that across the six identified domains, priorities related to systems strengthening received high levels of importance, as seen in this Likert scale distribution.

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the initiation of breastfeeding in the hospital as extremely important. In the infectious diseases domain, 63% and 45% of the respondents considered conducting research on diarrhoeal diseases and COVID-19 respectively, extremely important.

Overall ranking of research priorities

The highest ranked research priorities identified across domains were strengthening the public sector workforce (vaccine preventable diseases), enhancing public health surveillance networks (outbreak preparedness), nutrition support through community workers (primary care integration), encouraging at least 4–8 antenatal visits during pregnancy (maternal health), neonatal resuscitation to reduce birth asphyxia (neonatal health), and pediatric and maternal screening and treatment of tuberculosis (infectious diseases) (Table 2). While the Likert scale importance assignment and overall ranking exercises were in agreement across most domains, in the infectious diseases domain, a large proportion of respondents felt research on diarrhoeal disease prevention and treatment was extremely important; the ranking exercise, however, yielded pediatric and maternal screening and treatment for tuberculosis as the top priority.

Other research priorities identified

Several additional research topics were also suggested by the respondents across the six domains. Common themes identified were systems strengthening priorities like enhancing vaccine programme surveillance, empowering communities and community health workers, enhancing the quality of antenatal and postnatal care, and health systems strengthening for the infectious diseases domain. Other themes identified included women empowerment, family planning services, early childhood development and behavioural research. Novel research approaches for COVID-19 related research, and the use of technology like telemedicine, geographic information systems and artificial intelligence for the effective delivery of services across domains were also suggested, but these were not considered to be as important as system strengthening priorities during the ongoing COVID-19 pandemic.

Table 2. Top 3 ranked research priorities across each domain, by average ranking score.

Average ranking score†	Sub-domain research priority
Vaccine Preventable Diseases (maximum score = 10)	
8.03	Strengthening the public sector workforce
7.76	Areas of disparity, such as vaccination rates among the urban poor
7.48	Improving vaccination coverage and research opportunities
Outbreak Preparedness (maximum score = 7)	
5.63	Enhancing public health surveillance networks
4.91	Developing laboratory capacity and training
4.27	Assisting state government initiatives for disease surveillance
Primary Health Care Integration (maximum score = 6)	
4.42	Nutrition education support through community workers
4.22	Supplemental nutrition delivery and effectiveness
4.14	Growth monitoring through regular health visits
Maternal Health (maximum score = 8)	
6.45	Encouraging at least 4–8 antenatal visits during pregnancy
5.89	Improving facility-based safe delivery outcomes
5.32	Improving maternal immunization coverage
Neonatal Health (maximum score = 9)	
7.38	Neonatal resuscitation to reduce perinatal asphyxia
6.68	Improving quality of care during labor and birth
6.51	Improving initiation of breast feeding in hospital
Infectious Diseases (maximum score = 9)	
6.58	Pediatric and maternal screening and treatment for tuberculosis
6.48	COVID-19
6.38	Dengue prevention and management

† Average ranking score = $(x_1w_1 + x_2w_2 + x_3w_3 + \dots + x_nw_n) / \text{Total response count}$

Where, w = weight of ranked position; x = response count for each rank.

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Discussion

The key theme that emerged from this study seeking to identify MCH public health research priorities in India within the context of an unprecedented pandemic was the importance of systems strengthening rather than undertaking novel research. The findings of this exercise appeared to signal a shift from those of recent priority setting exercises in MCH, both from India and globally, which were conducted prior to the COVID-19 pandemic. Wazny *et al.* employed the Child Health and Nutrition Research Initiative (CHNRI) method for research priority setting for child health research in India for the period between 2016–2025, with research ideas crowd-sourced from a network of experts across India [11]. The majority of the top research priorities identified were related to the development of cost-effective interventions and their implementation, impact evaluations, improving data quality and monitoring of existing programs, and improving the management of morbidities [11]. An Indian Council of Medical Research study to identify top research priorities in MCH found that the delivery domain of research which included implementation research, constituted about 70% of the top ten research options [7]. A global exercise to characterize maternal and perinatal health priorities beyond 2015 identified research priorities that were mostly related to implementation research and the innovative development of simplified, cost-effective adaptations of existing interventions [8]. These studies also identified areas for novel or “discovery” research in

MCH, such as the development of innovative point of care diagnostics and technological solutions for acute maternal, neonatal and childhood morbidities, which were ranked high in priority lists. These studies employed the CHNRI method, which offers a detailed, systematic algorithm for the identification of research priorities that pools individual scorings of research options based on five weighted criteria, leveraging the collective wisdom of various stakeholders [12]. This method involves several stages, which could take months to complete. Other research priority setting exercises have utilized comprehensive approaches including the Combined Approach Matrix method, the Essential National Health Research (ENHR) method, Council on Health Research and Development (COHRED) method, the James Lind Alliance method and the Delphi method, most of which involve iterative processes which require substantial time and resources to complete [13]. Our study, positioned to fulfill the need for a rapid assessment during the COVID-19 pandemic found that prioritizing research endeavors in MCH to focus on strengthening existing service delivery was most important, and this theme was cross-cutting across the six domains. Further, despite the novelty of COVID-19, “discovery” research such as optimizing COVID-19 diagnostics and clinical management, and the development of an effective vaccine against COVID-19 did not receive high priority, emphasizing the perceived need to strengthen existing health systems to combat the unprecedented pandemic, rather than diverting scarce resources towards discovery research. COVID-19 vaccine research did not feature prominently amongst identified research priorities; we speculate that the most likely reason could be that expectations were low for having a fully developed vaccine within less than a year of virus discovery.

Epidemics in the past have demonstrated that they are highly disruptive to existing health systems. Studies conducted during the West African Ebola outbreak of 2014 have shown that the indirect effects of the pandemic on maternal health were severe, resulting in decreased utilization of antepartum, intrapartum, and postpartum care [14]. Significant decreases in coverage for most vaccines were also observed [15]. A prospective observational study at a tertiary hospital in India reported a reduction in institutional deliveries, increase in pregnancies with complications, and increase in intensive care unit admissions between the months of April–August 2020 [16]. Only a third of women had adequate antenatal care visits during this period [16]. Considering the threat posed by the pandemic on previous gains in MCH, focusing interventions and policies around the identified priority areas would be crucial to steadying the health outcomes of mothers and children.

An unintended consequence of lockdowns and movement restrictions resulting from the COVID-19 pandemic in LMICs like India is their influence on ongoing transmissions of other non-COVID related infectious diseases. India reports the highest burden of tuberculosis globally, accounting for a quarter of the 10 million global cases and 1.4 million deaths annually [17]. A recent modelling analysis of the impact on COVID-19 related disruptions in tuberculosis services in India showed that even temporary disruptions could cause long term increases in tuberculosis incidence and mortality [18]. In our study, under the infectious diseases domain, conducting research on tuberculosis was ranked as the top research priority, highlighting the fact that tuberculosis continues to remain highly relevant in the Indian setting, despite the emergence of COVID-19. Further, a majority of respondents also felt that conducting research on diarrhoeal diseases was extremely important, emphasizing the need to continue to focus efforts on the prevention and treatment of diarrhoeal diseases in the Indian context. The overall ranking for diarrhoeal diseases, however, occurred below that of tuberculosis, COVID-19, and dengue infections, underscoring the changing patterns of high-burden infectious diseases in India. The identification of non-COVID-19 infectious diseases as leading research priorities in the infectious diseases domain in a survey administered during the

unprecedented pandemic highlights the collective opinion of the respondents on the need to sustain research focus on other non-COVID-19 infectious diseases as well.

While there are useful lessons learned from these findings, the study limitations are worth noting. The survey was distributed within a short timeline between September–November 2020, and the results are limited by the small sample size. We acknowledge the potential presence of bias in the selection of key stakeholders for developing the survey, but obtained a final version via consensus, and have taken care to include a large and diverse respondent population. Since this was a rapid assessment, we did not perform specific sample size calculations that could have powered the study adequately to support generalizability of our findings. Additionally, we did not use qualitative methods to capture perspectives, and priorities were identified solely based on overall ranking and Likert scales. Further, the survey did not explore priorities for chronic and non-communicable diseases which have also witnessed an escalating burden in India in recent years. Diagnosis and treatment for such diseases have likely been affected by COVID-19 as well and warrant further research. We advise caution about generalization of these results as regional variations in ranking of priorities may not have been captured due to the small sample size of survey respondents. Despite these limitations, our study has been able to perceive a shift in research priorities for MCH towards systems strengthening during this unprecedented pandemic, and can serve as a valuable resource for donors, researchers and other stakeholders engaged in maternal and child health in India.

The COVID-19 pandemic and its response has significantly challenged health systems globally. It has exposed glaring loopholes in health systems, and has demonstrated that countries' response to pandemics is ultimately dependent on the resilience of their health systems [19]. Countries such as New Zealand, Sri Lanka, Taiwan and South Korea have been praised for their handling of the COVID-19 crisis; they were able to do so efficiently by investing heavily in their public health systems to improve testing, contact tracing and outreach measures early in the course of the pandemic [20]. Several countries from each of the six WHO regions are demonstrating that investing in stronger health systems is crucial in responding to COVID-19, delivering the best returns on investment and making health for all a reality [21]. In India, the private sector has remained a major player in healthcare delivery for several decades [22], but the ongoing pandemic has highlighted the indisputable role of the public health sector. The public health sector has not only shouldered a vast majority of preventive and outreach services, but also clinical care, with a substantial proportion of critical COVID-19 cases being treated by public health sector services [23]. States with robust, well-staffed and equipped public health systems have been more successful in containing the pandemic, and as a result, public health has reached the forefront of India's pandemic response and post-pandemic discourse. India's recent budget has promised substantial increases in healthcare allocation and investment on public health infrastructure [24], and these are welcome steps.

In conclusion, the results of this rapid assessment suggest that in order to build a sustainable future for maternal and child health during and post COVID-19 in India, national authorities should prioritize investments and develop frameworks to strengthen existing public health systems. Governmental investments in health research should be measured against defined benchmarks [25], and central and state governments should invest in building research capacity by developing a local workforce of well-trained and motivated researchers. Stronger collaborations between researchers and policymakers will ensure that research is taken outside the academic institutions and into public health programmes. Further, national research networks could be established to coordinate research efforts by fostering collaboration and information exchange between academic institutions, governmental and non-governmental organizations. Such partnerships could help in optimally tapping the individual



Fig 2. Recommendations for establishing research priorities in maternal and child health. Legend: General recommendations for establishing research priorities in maternal and child health in India. These recommendations have been informed by the results of this study, and our engagement with key stakeholders, and are in alignment with the World Health Organization's report on research for universal health coverage[†]. [†] World Health Organization. Research for universal health coverage: World health report 2013. Available at <https://www.who.int/publications/item/9789240690837>.

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sectors' strengths and contribute to the journey towards achieving the Sustainable Developmental Goals and Universal Health Coverage for all by 2030. Identifying and facilitating roles for public-private partnerships to support public health systems as well as research could further enable the most vulnerable populations to have access to healthcare [26]. General recommendations for establishing research priorities in maternal and child health in India are summarized in Fig 2; these have been informed by the results of this study, and our engagement with key stakeholders, and are in alignment with the World Health Organization's report on research for universal health coverage [27]. While our results highlight pivotal steps to the roadmap for sustaining and advancing maternal and child health during and after the COVID-19 pandemic in the Indian setting, these learnings are relevant to other emerging global economies as well, given the similarities in their respective health systems.

Supporting information

S1 File. Research needs in maternal and child health survey: India.

(DOCX)

S2 File. Raw data: Research needs assessment.

(DOCX)

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References

1. Ministry of Health and Family Welfare, Government of India. National Family Health Survey– 5 fact-sheet. [Available from: http://rchiips.org/nfhs/factsheet_NFHS-5.shtml]. Accessed June 2, 2021.
2. Ministry of Health and Family Welfare, Government of India. National Family Health Survey– 4 fact-sheet. [Available from: http://rchiips.org/nfhs/factsheet_nfhs-4.shtml]. Accessed June 2, 2021.
3. Kumari V, Mehta K, Choudhary R. COVID-19 outbreak and decreased hospitalisation of pregnant women in labour. *The Lancet Global health*. 2020; 8(9):e1116–e7. [https://doi.org/10.1016/S2214-109X\(20\)30319-3](https://doi.org/10.1016/S2214-109X(20)30319-3) PMID: 32679037
4. Ministry of Health and Family Welfare, Government Of India. Health management Information System. [Available from: <https://hmis.nhp.gov.in/#/>]. Accessed June 2, 2021.
5. Robertson T, Carter ED, Chou VB, Stegmuller AR, Jackson BD, Tam Y, et al. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. *The Lancet Global health*. 2020; 8(7):e901–e8. [https://doi.org/10.1016/S2214-109X\(20\)30229-1](https://doi.org/10.1016/S2214-109X(20)30229-1) PMID: 32405459
6. McGregor S, Henderson KJ, Kaldor JM. How are health research priorities set in low and middle income countries? A systematic review of published reports. *PloS one*. 2014; 9(9):e108787. <https://doi.org/10.1371/journal.pone.0108787> PMID: 25275315
7. Arora NK, Swaminathan S, Mohapatra A, Gopalan HS, Katoch VM, Bhan MK, et al. Research priorities in Maternal, Newborn, & Child Health & Nutrition for India: An Indian Council of Medical Research-INCLIN Initiative. *Indian J Med Res*. 2017; 145(5):611–22. https://doi.org/10.4103/ijmr.IJMR_139_17 PMID: 28948951
8. Souza JP, Widmer M, Gülmezoglu AM, Lawrie TA, Adejuyigbe EA, Carroli G, et al. Maternal and perinatal health research priorities beyond 2015: an international survey and prioritization exercise. *Reproductive health*. 2014; 11:61. <https://doi.org/10.1186/1742-4755-11-61> PMID: 25100034
9. SurveyMonkey.com. Ranking question. SurveyMonkey 2017. [Available from: https://help.surveymonkey.com/articles/en_US/kb/How-do-I-create-a-Ranking-type-question]. Accessed June 2, 2021.
10. World Health Organization. Health Systems Strengthening Glossary; 2019. [Available from: https://www.who.int/healthsystems/hss_glossary/en/index5.html#6]. Accessed June 2, 2021.
11. Wazny K, Arora NK, Mohapatra A, Gopalan HS, Das MK, Nair M, et al. Setting priorities in child health research in India for 2016–2025: a CHNRI exercise undertaken by the Indian Council for Medical Research and INCLIN Trust. *J Glob Health*. 2019; 9(2):020701. <https://doi.org/10.7189/jogh.09.020701> PMID: 31673343
12. Rudan I, Yoshida S, Wazny K, Chan KY, Cousens S. Setting health research priorities using the CHNRI method: V. Quantitative properties of human collective knowledge. *J Glob Health*. 2016; 6(1):010502. <https://doi.org/10.7189/jogh.06.010502> PMID: 27350873
13. Yoshida S. Approaches, tools and methods used for setting priorities in health research in the 21(st) century. *J Glob Health*. 2016; 6(1):010507. <https://doi.org/10.7189/jogh.06.010507> PMID: 26401271

14. Sochas L, Channon AA, Nam S. Counting indirect crisis-related deaths in the context of a low-resilience health system: the case of maternal and neonatal health during the Ebola epidemic in Sierra Leone. *Health policy and planning*. 2017; 32(suppl_3):iii32–iii9. <https://doi.org/10.1093/heapol/czx108> PMID: 29149310
15. Elston JW, Cartwright C, Ndumbi P, Wright J. The health impact of the 2014–15 Ebola outbreak. *Public health*. 2017; 143:60–70. <https://doi.org/10.1016/j.puhe.2016.10.020> PMID: 28159028
16. Goyal M, Singh P, Singh K, Shekhar S, Agrawal N, Misra S. The effect of the COVID-19 pandemic on maternal health due to delay in seeking health care: Experience from a tertiary center. *Int J Gynaecol Obstet*. 2020. <https://doi.org/10.1002/ijgo.13457> PMID: 33128794
17. World Health Organization. Global tuberculosis report 2020 [Available from: <https://www.who.int/publications/i/item/9789240013131>.] Accessed June 2, 2021.
18. Cilloni L, Fu H, Vesga JF, Dowdy D, Pretorius C, Ahmedov S, et al. The potential impact of the COVID-19 pandemic on the tuberculosis epidemic a modelling analysis. *EClinicalMedicine*. 2020; 28:100603. <https://doi.org/10.1016/j.eclinm.2020.100603> PMID: 33134905
19. Lal A, Erondy NA, Heymann DL, Gitahi G, Yates R. Fragmented health systems in COVID-19: rectifying the misalignment between global health security and universal health coverage. *Lancet* (London, England). 2021; 397(10268):61–7. [https://doi.org/10.1016/S0140-6736\(20\)32228-5](https://doi.org/10.1016/S0140-6736(20)32228-5) PMID: 33275906
20. Frieden T. Which Countries Have Responded Best to Covid-19? [Available from: <https://www.wsj.com/articles/which-countries-have-responded-best-to-covid-19-11609516800>]. Accessed June 2, 2021.
21. World Health Organization. Responding to COVID-19 and building stronger health systems for universal health coverage. [Available from: <https://www.who.int/news-room/feature-stories/detail/responding-to-covid-19-and-building-stronger-health-systems-for-universal-health-coverage>]. Accessed June 2, 2021.
22. Kasthuri A. Challenges to Healthcare in India—The Five A's. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine*. 2018; 43(3):141–3. https://doi.org/10.4103/ijcm.IJCM_194_18 PMID: 30294075
23. Shukla A. What lessons does the Covid-19 pandemic hold for India's health system? [Available from: <https://scroll.in/article/962794/what-lessons-does-the-covid-19-pandemic-hold-for-indias-health-system>]. Accessed June 2, 2021.
24. Ministry of Finance, Government of India. Budget Highlights. [Available from: <https://www.indiabudget.gov.in/doc/bh1.pdf>]. Accessed June 2, 2021.
25. World Health Organization. Research and Development to Meet Health Needs in Developing Countries: Strengthening Global Financing and Coordination. [Available from: https://www.who.int/phi/cewg_report/en/]. Accessed June 2, 2021.
26. Fanelli S, Salvatore FP, De Pascale G, Faccilongo N. Insights for the future of health system partnerships in low- and middle-income countries: a systematic literature review. *BMC health services research*. 2020; 20(1):571. <https://doi.org/10.1186/s12913-020-05435-8> PMID: 32571317
27. World Health Organization. Research for universal health coverage: World health report 2013. [Available from: <https://www.who.int/publications/i/item/9789240690837>]. Accessed June 2, 2021.