

# **Ethical Implications of Artificial Intelligence in Vaccine Equity: Exploring Vaccine Distribution Planning and Scheduling in Pandemics in Low-Middle-Income-Countries - Research Protocol**

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# Ethical Implications of Artificial Intelligence in Vaccine Equity: Exploring Vaccine Distribution Planning and Scheduling in Pandemics in Low-Middle-Income-Countries - Research Protocol

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## Abstract

**Background:** The COVID-19 pandemic highlighted significant disparities in vaccine distribution, particularly in Low- and Middle-Income Countries (LMICs). Artificial Intelligence (AI) has emerged as a potential tool to optimize vaccine distribution planning and scheduling. However, its ethical implications, including equity, transparency, bias, and accessibility, remain underexplored. Ensuring ethical AI implementation in vaccine distribution is crucial to addressing global health equity challenges.

**Objective:** This study aims to assess the ethical implications of AI-assisted vaccine distribution planning and scheduling in LMICs during pandemics. It seeks to evaluate AI's role in ensuring equitable vaccine access, analyze ethical concerns associated with its deployment, and propose an ethical framework to guide AI-based vaccine distribution strategies.

**Methods:** A multi-phase qualitative research approach is employed, combining a systematic scoping review, a witness seminar with key stakeholders (healthcare professionals, AI developers, policymakers, and bioethicists), and a meta-synthesis of findings. The scoping review follows PRISMA-ScR guidelines, focusing on studies from 2019-2023. The witness seminar provides firsthand insights into AI's ethical impact on vaccine equity. Thematic content analysis and qualitative coding will be used for data interpretation, with findings integrated into a policy-driven ethical framework.

**Results:** The study anticipates identifying key ethical challenges in AI-assisted vaccine distribution, such as algorithmic bias, privacy concerns, digital inequities, and regulatory gaps. It will highlight AI's potential to enhance vaccine logistics while simultaneously raising ethical dilemmas in decision-making and prioritization. Insights from the witness seminar will further inform the development of an ethical framework for AI-driven vaccine equity strategies in LMICs.

**Conclusions:** By examining the ethical implications of AI in vaccine distribution, this research will provide actionable recommendations for policymakers, healthcare organizations, and AI developers. The findings will contribute to the discourse on responsible AI deployment in global health, ensuring transparency, fairness, and inclusivity in pandemic response strategies. Clinical Trial: <https://osf.io/pk8eb>

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## Original Manuscript

*Ethical Implications of Artificial Intelligence in Vaccine Equity: Exploring Vaccine Distribution Planning and Scheduling in Pandemics in Low-Middle-Income-Countries - Research Protocol*

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***Abstract:***

**Background:** The COVID-19 pandemic highlighted significant disparities in vaccine distribution, particularly in Low- and Middle-Income Countries (LMICs). Artificial Intelligence (AI) has emerged as a potential tool to optimize vaccine distribution planning and scheduling. However, its ethical implications, including equity, transparency, bias, and accessibility, remain underexplored. Ensuring ethical AI implementation in vaccine distribution is crucial to addressing global health equity challenges. **Purpose:** This study aims to assess the ethical implications of AI-assisted vaccine distribution planning and scheduling in LMICs during pandemics. It seeks to evaluate AI's role in ensuring equitable vaccine access, analyze ethical concerns associated with its deployment, and propose an ethical framework to guide AI-based vaccine distribution strategies. **Method:** A multi-phase qualitative research approach is employed, combining a systematic scoping review, a witness seminar with key stakeholders (healthcare professionals, AI developers, policymakers, and bioethicists), and a meta-synthesis of findings. The scoping review follows PRISMA-ScR guidelines, focusing on studies from 2019-2023. The witness seminar provides firsthand insights into AI's ethical impact on vaccine equity. Thematic content analysis and qualitative coding will be used for data interpretation, with findings integrated into a policy-driven ethical framework. **Results:** The study anticipates identifying key ethical challenges in AI-assisted vaccine distribution, such as algorithmic bias, privacy concerns, digital inequities, and regulatory gaps. It will highlight AI's potential to enhance vaccine logistics while simultaneously raising ethical dilemmas in decision-making and prioritization. Insights from the witness seminar will further inform the development of an ethical framework for AI-driven vaccine equity strategies in LMICs. **Conclusion:** By

examining the ethical implications of AI in vaccine distribution, this research will provide actionable recommendations for policymakers, healthcare organizations, and AI developers. The findings will contribute to the discourse on responsible AI deployment in global health, ensuring transparency, fairness, and inclusivity in pandemic response strategies.

**Keywords:** Algorithmic Bias, Digital Inequities, Ethical Decision-Making, Vaccine Logistics, Health Equity

*Introduction*



The COVID-19 pandemic, which emerged in 2019, exposed critical weaknesses in global healthcare systems, particularly in the distribution and administration of vaccines. This crisis highlighted existing disparities in healthcare access, making vaccine equity; a principle ensuring fair and just vaccine distribution; a central concern.<sup>1</sup> Governments, international organizations, and healthcare authorities faced significant challenges in designing and implementing effective vaccine allocation strategies to ensure fair distribution across diverse populations.<sup>2,3</sup> Addressing these logistical challenges, requires technology playing a pivotal role in supporting vaccine distribution efforts, and with artificial intelligence (AI) emerging as a promising tool for enhancing efficiency and equity. AI has been widely applied in data analysis, pattern recognition, and predictive modeling.<sup>4,5</sup> During pandemics, AI could have the potential to optimize vaccine distribution by predicting outbreak hotspots, streamlining supply chains, and improving resource allocation. Its integration into vaccine planning and scheduling could improve both speed and fairness in distribution, particularly in resource-constrained settings.

However, vaccine equity is not solely a logistical issue; it also involves ethical and social considerations. Equitable access to vaccines must account for factors such as socioeconomic status, geographic location, race, gender, and other intersectional identities.<sup>6</sup> During a pandemic, structural inequalities often result in marginalized populations experiencing greater barriers to vaccination.<sup>7</sup> Additionally, the increasing reliance on digital technology raises concerns about digital inequity, as disparities in internet access, digital literacy, and technological infrastructure can further limit vaccine access for disadvantaged communities.<sup>8,9</sup> Addressing these challenges requires a system that prioritizes vulnerable populations, responsibly leverages AI, and promotes inclusive vaccine distribution strategies.

The application of AI in vaccine distribution also introduces complex ethical dilemmas.<sup>10,11</sup> Questions regarding prioritization, transparency, accountability, privacy, and fairness arise in AI-driven decision-making. AI systems, if not carefully designed, may reinforce biases, compromise trust, and shift critical healthcare decisions from human oversight to automated algorithms.<sup>4,12</sup> Balancing the efficiency of AI with ethical safeguards is crucial to ensuring public trust and equitable outcomes. Therefore, a thorough examination of the ethical implications of AI in vaccine distribution is necessary to guide its responsible implementation in future pandemic responses.

## *Methodology*

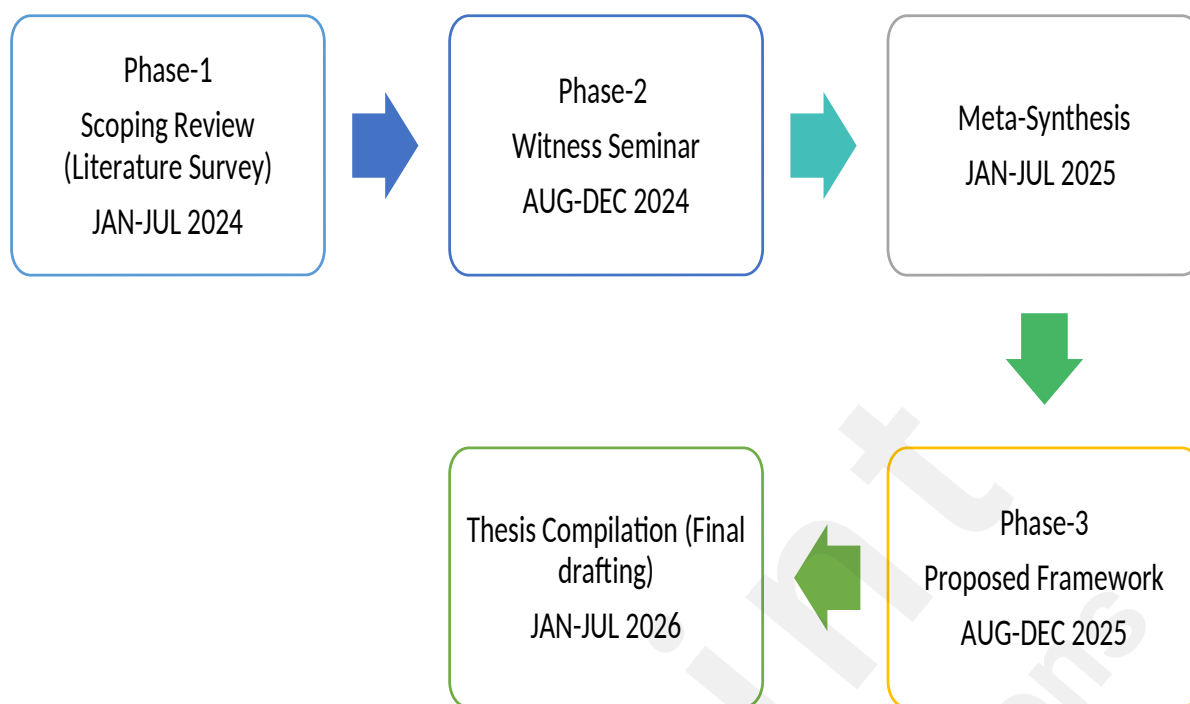
### *Ethical Approval and Consideration*

This study complies with ethical guidelines set by the Indian Council of Medical Research (ICMR, 2017) and the World Medical Association Declaration of Helsinki (WMA DoH, 2013). Approval from the Scientific Review Board (SRB) was obtained on 09/09/2023, and ethics clearance was granted by the Institutional Ethics Committee (IEC) on 05/10/2023. All participants in the witness seminar will provide written informed consent after reviewing the Participant Information Sheet (PIS), with the option to approve the edited transcript before publication. The study poses minimal to no risk, with no financial incentives, but offers academic contributions to public health ethics. Original recordings will remain confidential, while edited transcripts will be publicly available for research transparency.

### *Study Design*

This study employs a multi-phase qualitative research design guided by an interpretivism approach,<sup>13</sup> which emphasizes understanding the ethical implications of AI in vaccine distribution through the perspectives of key stakeholders. The study integrates a systematic scoping review, a witness seminar,<sup>14,15</sup> and a meta-synthesis,<sup>16</sup> ensuring a comprehensive exploration of AI's role in vaccine equity. Heterogeneous maximum variation sampling will be used to select diverse participants, including healthcare professionals, AI developers, policymakers, bioethicists, and vaccine recipients, to capture a broad spectrum of insights. The research aligns with Sustainable Development Goals (SDG) 9 (Industry, Innovation, and Infrastructure) and SDG 10 (Reduced Inequalities) by examining how AI-driven vaccine distribution can enhance technological equity while addressing disparities in global health. Through thematic content analysis and qualitative coding, the study aims to develop an ethical framework that promotes responsible and equitable AI implementation in pandemic response strategies.

### *Study Plan*



*Phase One:* The first phase of this study involves a systematic scoping review to analyze existing AI applications in vaccine equity, identifying key ethical considerations, challenges, and potential solutions. Following PRISMA guidelines, the review will include full-text, open-access peer-reviewed articles in English from PubMed, ScienceDirect, and DOAJ, covering the period 2019-2023 (COVID-19 pandemic). The study focuses on LMICs, examining how AI influences vaccine distribution planning and scheduling. Thematic analysis will be conducted, with data sourced from academic literature, government reports, and international health organizations. Heterogeneous maximum variation sampling ensures diverse stakeholder perspectives, including policymakers and healthcare professionals. Articles will be screened based on predefined Population (P), Concept (C), and Context (C) (PCC) criteria, excluding grey literature and unpublished sources. The review employs string-based searches using AI-related keywords to ensure comprehensive coverage of AI-driven vaccine allocation and ethical dilemmas.

*Phase Two:* The second phase of this study will involve a witness seminar, bringing together key stakeholders; healthcare professionals, policymakers, AI developers, bioethicists, and vaccine recipients; to share their firsthand experiences on AI's role in vaccine distribution during the COVID-19 pandemic. As a historical event, the pandemic provides an opportunity to document ethical challenges related to privacy, data security, algorithmic bias, and the impact on marginalized communities in LMICs. The seminar will be transcribed and thematically analyzed to extract critical insights.

*Phase Three:* The third objective involves developing an ethical framework for AI-supported vaccine distribution, utilizing meta-synthesis to integrate findings from the scoping review and witness seminar. Additionally, existing ethical frameworks and relevant case studies will be analyzed to shape a comprehensive model for responsible AI deployment in vaccine logistics. This multi-phase QUAL(quant) study, conducted at Yenepoya (deemed to be University), Mangalore, will span 18 months and rely on primary data collected from expert stakeholders.

#### *Sample Size*

A total of six to fifteen prospective witness panelists will be selected for the seminar, ensuring alignment with the study's research objectives and context. Participants will be chosen based on their expertise and direct relevance to AI-supported vaccine distribution, guaranteeing meaningful and insightful contributions. A smaller group size allows for focused, in-depth discussions, facilitating a comprehensive exploration of diverse viewpoints while maintaining high data quality. Additionally, resource constraints and feasibility considerations make a smaller, well-curated panel more manageable within the available timeframe and budget. The selection will also emphasize diversity in perspectives, fostering an environment of privacy and confidentiality, which encourages candid exchanges on the ethical implications of AI in vaccine equity.

#### *Recruitment*

A purposive sampling approach will be used to recruit key stakeholders, including healthcare professionals, policymakers, AI developers, bioethicists, and vaccine recipients with direct experience in AI-driven vaccine distribution, pandemic management, or health policy. Eligible participants must have at least one year of relevant experience, while those with less than a year or no direct involvement will be excluded. Witness panelists may withdraw consent at any time, in which case their identity will be anonymized, though their insights may still be used in the analysis. Discontinuation will occur if participants decline to participate, fail to respond within 15 days, or face relocation or scheduling conflicts that prevent their involvement.

#### *Semi-Structured Interview Guide Development*

A semi-structured interview schedule will be used as the primary research tool for the witness seminar, containing a list of open-ended questions designed to explore the ethical implications of AI in vaccine distribution. These questions are designed for clarity, and flexibility, allowing for probing and in-depth discussions that align with the study's objectives. There will be no fixed number of questions, as the inquiry process will emphasize knowledge and experience sharing among participants, that includes, probes.

Table 1: AI-based distribution planning and scheduling systems' effectiveness in ensuring

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## equitable vaccine distribution in LMICs

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### *Session 1: Opening and Introduction (5 minutes)*

- a) Brief overview of the seminar's purpose, objectives, and format
- b) Introduction of the panelists and their domain.

### *Session 2: COVID-19 vaccine access and vaccine equity (5 minutes' presentation to open up the discussion)*

- a) Each panelist presents their perspective on the COVID-19 vaccine access and vaccine equity during a the COVID-19 pandemic in LMICs. – (15 minutes)

### *Session 3: Utilizing of AI-support systems for vaccine scheduling and distribution (5 minutes' presentation to open up the discussion)*

- a) Each panelist presents their perspective on the utilization of AI- support systems on vaccine distribution during the COVID-19 pandemic in LMICs. – (15 minutes)

### *Session 4: Ethical implications of utilizing AI-support systems for vaccine scheduling and distribution and how it impacts equity (5 minutes' presentation to open up the discussion)*

- a) Each panelist presents their perspective on the ethical implications of AI- support systems for vaccine scheduling and distribution and how it impacts equity during the COVID-19 pandemic in LMICs. – (15 minutes)

### *Break: Refresh (10 minutes)*

### *Session 5: Health equity towards responsible AI implementation (5 minutes' presentation to open up the discussion)*

- a) Panelists share recommendations for responsible AI implementation in vaccine distribution to ensure equity and ethical considerations. – (15 minutes)
- 

### *Table 2: Interactive Discussion Questions (based on the sessions) also for the focus group interview.*

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### *Session 2: COVID-19 vaccine access and vaccine equity*

- a) How can AI be leveraged to enhance vaccine equity and promote equitable vaccine distribution? (registration, appointment scheduling, and outreach)

- b) How might the integration of AI into vaccine scheduling and distribution enhance access and equity?
- c) How will AI-based systems be made to recognize and address specific vulnerabilities of groups or biases in the processes that affect equitable distribution?
- d) How do AI-driven approaches impact the decision-making process for prioritizing vaccine distribution?
- e) How do you think AI can contribute to promoting vaccine equity?

*Session 3: Utilizing AI-support systems for vaccine scheduling and distribution*

- a) What potential challenges or limitations exist in implementing AI-driven approaches to enhance global health ethics in promoting vaccine equity?
- b) How might the integration of AI into vaccine scheduling and distribution enhance access and equity?

*Session 4: Ethical implications of utilizing AI-support systems for vaccine scheduling and distribution and how it impacts equity*

- a) What potential ethical challenges do you foresee in implementing AI-driven approaches for vaccine equity? (Individual privacy concerns, transparency, accountability, potential biases or inequalities, marginalization, cultural and social integration)
- b) What steps should be taken to address these limitations or unintended consequences that may arise from AI-driven approaches in vaccine distribution?

*Session 5: Health equity towards responsible AI implementation*

- a) What are the perceptions and attitudes of individuals towards AI-driven approaches in promoting vaccine equity, and how do these perceptions influence their willingness to participate?
- 

The interview schedule covers five key domains: AI in vaccine distribution, ethical implications of AI, vaccine distribution planning during pandemics, ethical considerations in vaccine scheduling, and equitable access to vaccines. Panelists will have the freedom to express their thoughts, emotions, and experiences to ensure a rich and nuanced discussion. To ensure validity, the interview schedule was reviewed by three experts, including one qualitative researcher and

two bioethicists. Following validation, necessary revisions were made before dissemination via email. Additionally, the questionnaire underwent pretesting with two prospective panelists; who will not participate in the final seminar; to assess clarity, coherence, and language accuracy, ensuring the questions are easily understood and effectively elicit relevant responses.

### *Semi-Structured Interview Administration*

The witness seminar will be conducted in a structured and interactive format to gather insights from expert panelists on the ethical implications of AI in vaccine equity during pandemics. Invitations will be sent to selected stakeholders, including healthcare professionals, policymakers, AI developers, bioethicists, and vaccine recipients, who have firsthand experience in AI-based vaccine distribution. The seminar will be held in a hybrid mode, with the physical venue at the Demo Room II, 3rd floor, Centre for Ethics, Yenepoya (deemed to be University), Mangalore, and a Zoom link for online participants. To ensure informed discussions, panelists will receive background reading materials before the event, with downloadable links provided during registration. A question schedule will guide discussions, prompting participants to share their experiences, ethical concerns, and recommendations regarding AI-driven vaccine allocation.

The entire session will be recorded with participant consent, and comprehensive notes will be taken to capture key insights, perspectives, and areas of agreement or disagreement. Following the seminar, the recordings will be transcribed, and thematic analysis will be conducted to identify emerging patterns and ethical concerns. Panelists will have the opportunity to review and verify the accuracy of the findings before dissemination. The final report, including key discussion points and recommendations, will be shared with stakeholders, policymakers, and the broader research community through publications, presentations, or policy briefs. This process ensures transparency, accuracy, and meaningful contributions to the ongoing discourse on ethical AI implementation in vaccine distribution.

### *Data Analysis Plan*

A holistic approach will be used to analyze the qualitative data, providing a comprehensive understanding of AI's impact on vaccine equity, distribution, planning, and scheduling during pandemics. The witness seminar transcripts will undergo content analysis, identifying key themes, patterns, and ethical concerns related to AI-driven vaccine allocation in LMICs. Thematic insights will be extracted through focused coding, while summative content analysis will be used to map responses against established ethical principles. The Principal Investigator (PI) will independently conduct the initial analysis, which will then be reviewed and compared with findings from the research guides (Co- Investigators) to ensure accuracy and consistency.

For content analysis insights, data will be analyzed using Biblioshiny, and R-Studio to identify trends, associations, and statistical patterns related literatures on AI-supported vaccine distribution systems. The study will adopt descriptive analysis to provide empirical evidence on how AI interventions influence equity and efficiency in pandemic response. Additionally, witness seminar participants will engage in a consensus-based content mapping process, ranking ethical concerns based on their contextual relevance and impact. The final results will inform the development of an ethical framework for the responsible use of AI in vaccine distribution, contributing to policy recommendations and future AI governance in global health.

### *Trustworthiness of the Study*

Ensuring the trustworthiness of this study is critical to establishing the rigor, reliability, and validity of the findings. This is achieved through credibility, transferability, dependability, and confirmability, supported by multiple verification techniques.

#### *Credibility*

The study incorporates triangulation, member checking, and negative case analysis. Triangulation is achieved through a multi-phase approach, integrating data from a systematic scoping review, a witness seminar, and meta-synthesis to ensure a comprehensive understanding of AI's ethical implications in vaccine equity. Member checking will allow witness seminar participants to review edited transcripts and verify the accuracy of their statements before finalizing the analysis. Additionally, negative case analysis will be conducted by identifying divergent perspectives on AI implementation in vaccine distribution, ensuring that all viewpoints are represented.

#### *Transferability*

The study provides a reasonable description of the research context, including detailed participant experiences, ethical challenges, and AI's impact on vaccine distribution in LMICs. Through the documentation of specific factors influencing AI-based vaccine allocation, the findings can be applied in similar settings globally.

#### *Dependability*

The study ensures dependability through an audit trail, systematically documenting all research steps, from protocol development to data collection, analysis, and reporting. A structured data management approach will be followed, with the Principal Investigator (PI) and research guides independently reviewing findings to ensure consistency and replicability.

#### *Confirmability*

The research process will be transparent and objective, minimizing potential researcher bias. The audit trail will maintain records of data collection methods, coding processes, and analysis decisions to allow external validation.

### *Reflexivity*

A reflexive approach will be maintained throughout the study to acknowledge and address potential researcher biases. This involves continuous self-evaluation and critical reflection on how the researchers' backgrounds, perspectives, and assumptions may shape data interpretation.

### *Discussion*

This study highlights the ethical implications of AI-driven vaccine distribution, particularly in LMICs, where disparities in healthcare access are prevalent.<sup>17,18</sup> The preliminary review emphasize that while AI-based distribution systems can enhance efficiency, forecasting, and equitable allocation, they also introduce challenges related to algorithmic bias, data privacy, transparency, and accessibility.<sup>19,20</sup> The witness seminar insights could reveal concerns about digital inequity, decision-making autonomy and trust in AI systems where populations with limited technological access may be disadvantaged in AI-driven vaccine scheduling. The integration of systematic scoping review, witness seminar, and meta-synthesis provided a triangulated perspective, offering a holistic understanding of AI's role in vaccine distribution. The study emphasizes on the importance of developing ethical framework that could address bias mitigation, data protection, and equitable AI implementation. Moreover, aligning AI-driven vaccine strategies with Sustainable Development Goals (SDG 9 & 10) could help bridge technological and healthcare inequalities. Future research should explore context-specific AI adaptations, ensuring that AI-driven vaccine logistics prioritize inclusivity, ethical responsibility, and equitable healthcare access in global pandemic preparedness.

### *Conclusion*

This study explores the ethical implications of AI in vaccine distribution, particularly in LMICs, where access disparities persist. Integrating a systematic scoping review, witness seminar, and meta-synthesis to provide insights into both the potential benefits and ethical challenges of AI-driven vaccine allocation. The findings could inform policymakers and healthcare professionals, offering practical recommendations for responsible AI deployment in pandemic response efforts. Additionally, the study aims to develop an ethical framework to guide equitable and transparent AI implementation in vaccine distribution. Through stakeholder engagement and policy recommendations, this research contributes to ethical AI governance in global health. The generalizability of findings to different LMICs may pose limitations. However, this study can serve as a model for new learnings, offering valuable insights that can be adapted and refined for

similar research and policy development.

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### *Contributions*

Akuma Ifeanyichukwu, Dr. Vina Vaswani, and Dr. Perihan Elif Ekmekci, contributed to conceptualization, methodology, final draft and approval for submission of the protocol.

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### *Ethics approval and consent to participate*

The protocol was approved by institutional Scientific Review board and Ethics Committee, of Yenepoya Medical College, Yenepoya (deemed to be University) Mangalore, Karnataka, India in accordance with the Indian Council of Medical Research (ICMR) and Declaration of Helsinki (DoH) guidelines. YEC-1/2023/269.

### *Conflict of Interest*

The authors do not have any competing interest

### *Data-Availability Statement*

The data generated and analyzed during the interview will be made publicly available and upon reasonable request but as of the time of this protocol publication, there are no data available.

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### *Reference*

1. Kontogiannis, T. (2021). A qualitative model of patterns of resilience and vulnerability in responding to a pandemic outbreak with system dynamics. *Safety Science*, 134, 105077. Doi: 10.1016/j.ssci.2020.105077
2. Parveen, M. (2020). Challenges Faced by Pandemic Covid 19 Crisis: A Case Study in Saudi Arabia. *Challenge*, 63(6), 349–364. Doi:10.1080/05775132.2020.1822659
3. Hammami, R., Salman, S., Khouja, M., Noura, I., & Alaswad, S. (2023). Government strategies to secure the supply of medical products in pandemic times. *European Journal of Operational Research*, 306(3), 1364–1387. Doi:

10.1016/j.ejor.2022.07.007

4. Das, A. K., Bera, B., & Giri, D. (2021). AI and Blockchain-Based Cloud-Assisted Secure Vaccine Distribution and Tracking in IoMT-Enabled COVID-19 Environment. *IEEE Internet of Things Magazine*, 4(2), 26–32. Doi: 10.1109/iotm.0001.2100016
5. Chowdhury, D., Poddar, S., Banarjee, S., Pal, R., Gani, A., Ellis, C., Arya, R. C., Gill, S. S., & Uhlig, S. (2022). <scp>CovidXAI</scp>: explainable<scp>AI</scp>assisted web application for<scp>COVID</scp>-19 vaccine prioritization. *Internet Technology Letters*, 5(4). Portico. Doi: 10.1002/itl2.381
6. Gómez-Ramírez, O., Iyamu, I., Ablona, A., Watt, S., Xu, A. X. T., Chang, H.-J., & Gilbert, M. (2021). On the imperative of thinking through the ethical, health equity, and social justice possibilities and limits of digital technologies in public health. *Canadian Journal of Public Health*, 112(3), 412–416. Doi: 10.17269/s41997-021-00487-7
7. Ahmed, A., Lundahl, M., & Wadensjö, E. (2023). Ethnic Discrimination During the Covid-19 Pandemic. *Migration and Integration in a Post-Pandemic World*, 291–314. Doi: 10.1007/978-3-031-19153-4\_11
8. Zheng, Y., & Walsham, G. (2021). Inequality of what? An intersectional approach to digital inequality under Covid-19. *Information and Organization*, 31(1), 100341. Doi: 10.1016/j.infoandorg.2021.100341
9. Imran, A. (2022). Why addressing digital inequality should be a priority. *THE ELECTRONIC JOURNAL OF INFORMATION SYSTEMS IN DEVELOPING COUNTRIES*, 89(3). Portico. Doi: 10.1002/isd2.12255
10. Grady, C., Shah, S., Miller, F., Danis, M., Nicolini, M., Ochoa, J., Taylor, H., Wendler, D., & Rid, A. (2020). So much at stake: Ethical tradeoffs in accelerating SARSCoV-2 vaccine development. *Vaccine*, 38(41), 6381–6387. Doi: 10.1016/j.vaccine.2020.08.017
11. Gur-Arie, R., Jamrozik, E., & Kingori, P. (2021). No Jab, No Job? Ethical Issues in Mandatory COVID-19 Vaccination of Healthcare Personnel. *BMJ Global Health*, 6(2), e004877. Doi:10.1136/bmjgh-2020-004877
12. Khan, J. I., Khan, J., Ali, F., Ullah, F., Bacha, J., & Lee, S. (2022). Artificial Intelligence and Internet of Things (AI-IoT) Technologies in Response to COVID-19 Pandemic: A Systematic Review. *IEEE Access*, 10, 62613–62660. Doi: 10.1109/access.2022.3181605
13. Keane, E., & Thornberg, R. (2024). Grounded Theory and Constructivist Grounded

- Theory in Educational Research. The Routledge International Handbook of Constructivist Grounded Theory in Educational Research, 32–61. Doi: 10.4324/9781003425403-3
14. Maas, H. (2018). The witness seminar. *A Contemporary Historiography of Economics*, 57–72. Doi: 10.4324/9781315169194-5
  15. Nicholls, E. J. (2020). The witness seminar: A research note. *Qualitative Research*, 22(1), 166–173. Doi: 10.1177/1468794120974153
  16. Walsh, D., & Downe, S. (2005). Meta-synthesis method for qualitative research: a literature review. *Journal of Advanced Nursing*, 50(2), 204–211. Portico. Doi: 10.1111/j.1365-2648.2005.03380.x
  17. Asundi, A., O’Leary, C., & Bhadelia, N. (2021). Global COVID-19 vaccine inequity: The scope, the impact, and the challenges. *Cell Host & Microbe*, 29(7), 1036–1039. Doi: 10.1016/j.chom.2021.06.007
  18. Buccieri, K., & Gaetz, S. (2013). Ethical Vaccine Distribution Planning for Pandemic Influenza: Prioritizing Homeless and Hard-to-Reach Populations. *Public Health Ethics*, 6(2), 185–196. Doi: 10.1093/phe/pht005
  19. Van De Pas, R., Widdowson, M.-A., Ravinetto, R., N Srinivas, P., Ochoa, T. J., Fofana, T. O., & Van Damme, W. (2021). COVID-19 vaccine equity: a health systems and policy perspective. *Expert Review of Vaccines*, 21(1), 25–36. Doi: 10.1080/14760584.2022.2004125
  20. Yarlagadda, H., Patel, M. A., Gupta, V., Bansal, T., Upadhyay, S., Shaheen, N., & Jain, R. (2022). COVID-19 Vaccine Challenges in Developing and Developed Countries. *Cureus*. Doi: 10.7759/cureus.23951