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Research article

Knowledge, attitudes and practices related to climate change and its health aspects among the healthcare workforce in India – A cross-sectional study

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ABSTRACT

Introduction: Climate change is one of the greatest global health challenges of the 21st Century. India is especially vulnerable to climate change due to its geographic location, climate-sensitive livelihoods and prevalent health concerns. In that context, the healthcare workforce plays a critical role in addressing climate change and its health effects. While some initiatives are underway to equip the healthcare workforce in India, their understanding and interest to engage with this challenge was unknown. We conducted a cross-sectional study to assess the knowledge, attitudes and practices related to climate change and health among the healthcare workforce in India (i.e., community health workers, doctors, etc.).
Methods: A structured questionnaire was administered to participants between October and December 2020. The collected data (n = 3062) were analyzed descriptively.
Results: We found that although knowledge about climate change and its immediate health effects due to exposure to heat (80.9%), cold (79.2%) and disease vectors (79.1%) were prevalent among the respondents, awareness about the delayed or indirect health effects such as malnutrition was relatively low (58.4%). Several participants reported an interest to learn more about climate change, for instance, about linkages between infectious disease outbreaks and climate change (72.7%), and the role of health professionals in creating awareness on climate change (43.9%).
Conclusions: While additional research is needed to understand the roles and motivations of various healthcare actors to address these challenges, our findings are encouraging towards further interventions in this area. Our study also provided insights on the preferences regarding the communication media and material on climate change and health by the healthcare workforce. There is a need to enable climate-resilient health systems in India and in other countries that are disproportionately vulnerable to climate change, and studies such as this one can help in that direction.

1. Introduction

The World Bank Group estimates that by 2030, globally, more than 100 million people could be dragged into extreme poverty by climate change and this would be mainly due to the negative impacts on population health [1]. It is also projected that low- and middle-income countries will be the worst affected because they are disproportionately exposed, and also due to the weaker adaptive capacity in terms of health systems and other infrastructure. Most countries are working towards achieving the health-related Sustainable Development Goals, but climate change threatens to undermine these efforts through various impacts on health and healthcare infrastructure. Climate change is already impacting human health in a variety of ways, for instance, through frequent and intense extreme weather events such as storms and floods, and also water scarcity [2–5]. Hence, there is a need to strengthen efforts towards addressing the impacts of climate change, including health systems [6].

India, the second most populous country in the world, is one of the most vulnerable to climate change and its effects [7]. Climate projections from a recent Government of India report do not bode well for population health, natural ecosystems, agricultural output, freshwater resources, infrastructure and the economy in the country [8]. India is already characterised by large disparities, for example, with

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21% of the population living below the poverty line [9], and with large health disparities in terms of prevalence of diseases and access to healthcare between the richest and poorest sections of the population [10]. And while the country's greenhouse gas emissions (GHG) have been gradually increasing in the recent past [11], the country's per capita GHG emissions (1.8 t of carbon dioxide equivalent) continues to be low when compared to the global average (4.5 t per capita) [12]. India's energy production, like all other countries, is mainly dependent on fossil fuels. The draft National Energy Policy 2017 indicates that the installed coal-based electricity generation capacity is expected to grow to 441 gigawatts by 2040 [13].

The special report by the Intergovernmental Panel on Climate Change (IPCC) unambiguously stated that prevention of climate change-related mortality and morbidity will entail limiting global warming to 1.5 °C above pre-industrial levels. However, the global warming trajectory for this century is 2.7–3.1 °C [14]. IPCC's Assessment Report 6 has indicated that every tenth of a degree rise in excess of 1.5 °C will have serious implications on people's health and lives.

Given this situation, the health sector plays a very important role in effectively responding to the challenges of climate change [1] both in terms of managing the unavoidable health effects of climate change, and also mitigating greenhouse gas emissions from the health sector. Hospitals and public health professionals are first responders to the health effects of climate change, but their ability to respond can be affected by vulnerable health systems. In that context, Kerala state in India has piloted climate-resilient primary health centres in areas that were affected by floods in 2018 [15]. In addition, small initiatives towards mitigating climate change have also been undertaken. The All India Institute of Medical Sciences, New Delhi is working towards reducing carbon intensity by over 30% [16], and non-profit organisations such as SELCO Foundation are supporting the installation of solar energy solutions for remote primary health centres [17]. These are encouraging developments, which demonstrate the potential to work towards mitigation and adaptation within the health sector, while not losing sight of the primary challenge of improving access to quality healthcare in these settings.

Healthcare professionals are also considered as credible sources of health information [18]. Voices from the health sector have been further amplified during the COVID-19 pandemic [19]. In this context, various studies have been conducted worldwide to understand about the views of health professionals and workers on climate change as a health issue, for instance, from China (among public health and nursing students [20] and public health nurses [21]), the USA (among nurses [22] and physicians [23]), and Italy (among healthcare professionals and students [24]). The study conducted in China among the public health and nursing students [20] found that 88% of the respondents recognised that climate change was bad for human health, and 67% believed that the impacts of climate change are controllable. Findings from another recent large, multinational survey of health professionals (n = 4654) from 12 health professional organisations (medical and nursing) around the world revealed that participants understood that climate change is happening (95%) and that it was caused by human activities (81%), that climate change was an important and growing cause of health impacts in their patients (77%) as well as for future generations (93%), and recognised that they have a responsibility to create awareness among the public (86%) and policymakers (90%) about climate change and its health effects [25]. In India, studies on knowledge, attitudes and practices (KAP) among healthcare professionals on biomedical waste management [26–32], vector-borne disease outbreaks [33], infection control [34] and COVID-19 management [35–37] have been reported; however, there was no literature on KAP on climate change and health. Considering India's vulnerability to climate change, it would be useful to understand how the healthcare workforce in India perceives and relates to the challenge of climate change, its health effects and the role of the health sector.

The objective of the current study was to understand the awareness, views, and actions being undertaken by various subgroups of the healthcare workforce in India on climate change and its health effects. The issues and gaps thus identified would help address the larger goal of supporting the health system prepare for climate change-related impacts, including the development of group-specific learning material on climate change and its health effects. This study is part of a larger project that aims to improve motivation and competence among the healthcare workforce to address the health effects of climate change.

2. Methods

2.1. Ethical clearance

The ethical clearance was obtained from State Health Resource center, Raipur, Chhattisgarh (Letter No./695/SHRC/2020). The potential participants were contacted through telephone calls or physical meetings, and were explained about the study and about how their data will be recorded, managed and used. Then they were asked for their consent (verbally) to participate in this study. Individuals who consented were included in this study.

2.2. Study design and study site

A cross-sectional study was designed and carried out through a survey involving doctors, nurses, paramedical staff, hospital administrators, ASHAs (Accredited Social Health Activists), public health professionals and healthcare students. To have adequate geographic representation from across the country, India was categorized into six different zones, namely (i) Northern zone; (ii) Southern zone; (iii) Eastern zone; (iv) Western zone; (v) Central zone; and (vi) Northeastern zone. The states in each of the zones were line listed and one state was selected from each zone by generating random numbers in Microsoft Excel. Using a similar technique, two districts (one urban and one rural) were chosen from each state. The following states were chosen for the study: Uttar Pradesh (Northern Zone), Karnataka (Southern Zone), Bihar (Eastern Zone), Maharashtra (Western Zone), Chhattisgarh (Central Zone) and Meghalaya (Northeastern Zone) (Fig. 1).

2.3. Study sample and sampling approach

2.3.1. Study population

There were seven subgroups of the healthcare workforce:

- "ASHA workers" include ASHAs, who are trained community-based liaisons between the community and the health system.
- "Doctors" include persons with one of the following qualifications: Bachelor of Medicine and Bachelor of Surgery (MBBS), Bachelor of Dental Surgery (BDS), graduates of other systems (e.g., ayurveda), Physiotherapy (BPT), and any higher-level training in medicine and surgical fields (for instance, MD and MS).
- "Hospital administrators" include public relations consultants, lower division assistants, data entry operators, health assistants, block program officers, clerks, accountants, receptionists, and hospital management.
- "Nurses" include General Nursing and Midwifery (GNM) graduates, auxiliary nurse midwives (ANM), intensive care ward nurses, staff nurses, nursing superintendents, dental nurses, nursing tutors, nursing officers, and operation theater nursing officers.
- "Paramedical staff" include radiographers, physiotherapists (diploma graduates), pharmacists, lab technicians, operation theater technicians, speech therapists, radiology technicians,

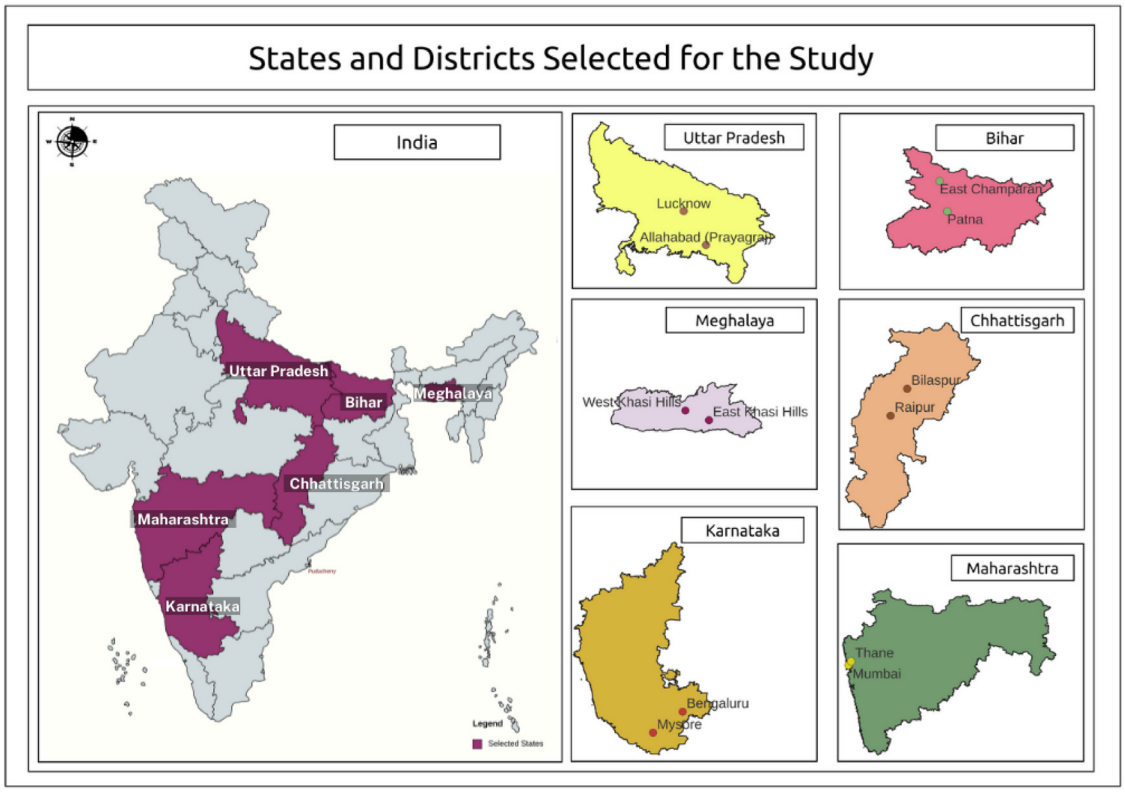

Fig. 1. *Study sites*; states included in the study indicated in maroon color (left panel); districts included from each of the selected states are indicated by dots on the state maps in the six panels on the right.

anesthesia assistants, dieticians, perfusionists, sanitation and dialysis technicians.
- "Public health professionals" include counsellors, outreach workers, public health surveyor, office assistants, project managers, community organizers, social workers, project directors, program coordinators, health club workers, trainers, and research assistants
- "Healthcare students" include students pursuing undergraduate and postgraduate degrees in various systems of medicine, pharmacy, nursing, and biotechnology

2.3.2. Sampling approach

To estimate the required sample size, it was assumed that 50% of the population (each sub-group) know about climate change, and an absolute precision of 5% was accepted. A sample size estimate of 384 individuals for each subgroup was arrived at. So, a minimum of 2688 individuals were required for the study (384×7 subgroups). From each of the six selected states, we needed 64 individuals from each subgroup of the workforce. Clustering was not accounted for.

Several approaches were used to identify potential participants as there was no ready sampling frame. The following medical databases were used to identify the doctors: *Dial me 24, Scribe, AWS Database Provider, B2B Database Provider, Yes Data, Click UP, Lime Leads, and Yellow pages.* In addition, contacts of potential respondents were obtained through networks such as Indian Medical Association (IMA), National Health Mission (NHM), medical colleges and non-profits like Lung Care Foundation and Doctors For You. We approached all eligible doctors for whom contact information was obtained. Participants for the other streams of healthcare workforce were identified from the references received from doctors, hospitals and associations, and so it was a snowball sample for non-medical healthcare workers.

2.4. Data collection

A questionnaire was developed to understand the knowledge (e.g., awareness of the term climate change, causes/reasons of climate change), attitudes (e.g., interest to know more about impacts of climate change on health) and practices (e.g., engaged in communicating about climate change) of the study participants. The questionnaire was first pilot-tested with seven healthcare professionals consisting of two medical school academicians, a public health PhD student, a medical officer, a nurse, and two Ayurveda practitioners who were also public health graduates. They were from Tamilnadu, Kerala and Maharashtra states. The pilot questionnaire was in the English language. Five participants responded to the survey online, and two were interviewed over telephone. The feedback was positive and the responses pointed to some gaps in the questionnaire based on which some changes were made. The final questionnaire was translated into other regional languages based on our study sites (Hindi, Marathi and Kannada). The questionnaires in the regional languages were back-translated to English to check the validity of the questionnaire.

The survey was conducted from October to December 2020 by a company that is experienced in conducting surveys [38]. The modes of survey administration included: telephone call, online form, and in-person interview. Due to the COVID-19 pandemic, many healthcare professionals were unable to participate in telephonic interviews. Hence, in-person data collection was also carried out following the necessary safety protocols.

2.5. Analysis

The data were downloaded from the data collection platform developed on SurveyCTO (Open Data Kit), and then analysed using IBM SPSS v19 software. The data were cleaned, and units with incomplete data were excluded from the analysis. The data were summarised descriptively for the various categories of healthcare personnel

included in this study. This implied using proportions and means to understand the status of knowledge, attitudes and practices related to climate change and health. Confidence intervals (95% CI) were also calculated for the estimated proportions to account for random error.

3. Results

A total of 5850 potential respondents were approached, of whom 3185 individuals answered the survey (response rate of 54.4%). Of these, 123 responses did not include adequate socio-demographic details of the participants, and were excluded. In total, 3062 responses were considered for data analysis.

Out of the above seven subgroups of the healthcare workforce, six, namely ASHA workers (100.0%), doctors (85%), hospital administrators (75.5%), nurses (72.7%), paramedical staff (73.2%) and healthcare students (81.8%), were mainly from the public (governmental) sector. All the public health professionals were from the private (non-profit) sector.

The average age of the participants was 33 years (standard deviation ±9 years), and 51.6% were female (varied between 100% among ASHAs and 26.6% among public health professionals). Educational status and years of experience also varied widely between the subgroups. Socio-demographic characteristics of the participants are summarised in Table 1.

3.1. Knowledge about climate change and its health effects

Relatively higher proportion of doctors acknowledged that air quality-related illness (94.9%), heat-related illness (88.6%), cold-related illness (84.7%), vector-borne infectious diseases (89.2%), water-borne infectious diseases (88.2%), mental health conditions (80.0%) and allergic conditions (84.1%). A higher proportion of healthcare students identified malnutrition (70.3%) and social conflicts (61.8%) as health effects of climate change (Table 2). Most respondents also recognised an increasing burden of climate-sensitive diseases (74.3%).

While the majority of the respondents (68%) felt everyone was affected by climate change, children (82.9%) were perceived as the most affected followed by the elderly (80.2%). There was not much difference in the perception on women and men being most affected (63.5% and 60.5% respectively). A higher proportion of doctors (75.7%) felt that men were most affected by climate change, public health professionals that women were most affected (70.4%), and healthcare students that children (89.3%) and the elderly (90.4%) were most affected by climate change (Table 3).

Awareness on governmental initiatives like the National Action Plan on Climate Change and Human Health (NAPCCHH) (72.6%), air pollution monitoring and action plan (68.9%), and other initiatives such as green hospitals initiative (68.5%) were prevalent as compared to the awareness on heat action plans (43.5%). A higher proportion of the public health professionals reported awareness of the climate action plan developed by Ministry of Health and Family Welfare (MoHFW) (77.7%), whereas a greater proportion of the doctors were aware of the heat action plan (66.1%) and air pollution monitoring and action plan (89.2%) (Table 4).

Most of the respondents (71.4%) were aware of one or more of the various anthropogenic causes of climate change. The majority of the respondents dismissed "God's will" as a cause of climate change (85.0%). The contribution of industrial livestock farming was the least reported driver of climate change by the respondents (42.8%) (table I available in the Appendix). As for the knowledge about impacts of climate change, most respondents indicated about the increased occurrences of extreme weather events, change in rainfall pattern (82.2%) and flooding (81.4%). The respondents' awareness of the impacts of climate change with respect to groundwater scarcity (51.7%), deaths due to drowning (43.9%), increased cases of allergies (64.0%), and

Table 1
Socio-demographic characteristics of the study participants (n = 3062).

	ASHA workers n = 416	Doctors n = 510	Hospital administrators n = 369	Nurses n = 498	Paramedical staff n = 443	Public health workers n = 368	Healthcare students n = 458	Total n = 3062
Age in years (Mean (SD*))	36.8 (6.3)	39.8 (10.7)	34.8 (7.1)	32.0 (7.9)	32.7 (7.2)	33.2 (6.0)	22.7 (2.6)	33.1 (8.9)
Female (%)	100.0	34.7	33.1	77.7	36.3	29.6	51.1	51.6
Education (%)								
Schooling	78.6	0	48.0	18.1	9.9	33.4	0.4	26.9
Diploma	0	0	1.9	35.5	20.8	0.5	6.1	9.4
Under-graduate	15.4	44.5	37.9	40.0	60.5	42.4	86.5	46.6
Post-graduate and above	6	55.5	12.2	6.4	8.8	23.6	7	17
Years of experience (%)								
< 5 years	31.5	24.7	40.7	54.4	49.2	41.6	99.1	48.7
5 – 10 years	46.2	19.2	24.4	19.3	25.7	28.8	0.9	23.5
>10 years	22.4	56	35	26.3	25.1	29.6	0	27.7

* SD, standard deviation.

Table 2
Knowledge on climate change and its health effects among the study participants (n = 3062).

Climate change and health impacts	ASHA workers (%)	Doctors (%)	Hospital administrators (%)	Nurses (%)	Paramedical staff (%)	Public health professionals (%)	Healthcare students (%)	TOTAL n = 3062 (%) (95% CI)
Air quality-related illness	85.1	94.9	88.9	89.0	85.3	82.1	93.4	88.4 (87.2, 89.5)
Heat-related illness	78.6	88.6	81.6	76.7	83.1	75.8	81.9	80.9 (79.5, 82.2)
Cold-related illness	81.0	84.7	78.0	77.1	79.2	77.2	77.1	79.2 (77.7, 80.6)
Vector-borne diseases	71.9	89.2	76.2	76.5	75.2	78.8	86.2	79.1 (77.6, 80.5)
Water-borne diseases	69.0	88.2	73.4	79.9	73.8	75.0	83.8	77.6 (76.1, 79.0)
Allergic reactions	66.8	84.1	66.4	70.9	69.1	64.1	76.2	71.1 (69.5, 72.6)
Mental health conditions	56.3	80.0	66.9	71.1	63.7	69.3	74.9	68.9 (67.2, 70.5)
Malnutrition	55.8	66.7	49.9	62.9	54.0	42.9	70.3	57.5 (55.7, 59.2)
Social Conflicts	47.6	52.4	41.5	56.6	45.8	37.2	61.8	49.7 (47.9, 51.5)

Table 3
Groups perceived to be most affected by climate change and its health effects (n = 3062).

Most affected people by climate change	ASHA workers (%)	Doctors (%)	Hospital administrators (%)	Nurses (%)	Paramedical staff (%)	Public health professionals (%)	Healthcare Students (%)	TOTAL n = 3062 (%) (95% CI)
Children	82.0	86.1	84.6	75.9	76.5	85.6	89.3	82.9 (81.5, 84.2)
Elderly	79.6	77.3	80.8	77.1	75.8	80.4	90.4	80.2 (78.8, 81.5)
All age groups	71.9	65.7	65.3	61.6	64.6	76.1	71.0	68.0 (66.3, 69.7)
Women	64.4	59.2	66.9	61.0	56.9	70.4	65.7	63.5 (61.8, 65.1)
Men	53.4	75.7	60.2	57.8	51.0	59.5	66.2	60.5 (58.8, 62.2)

Multiple responses were allowed, and hence they don't add up to 100%.

Table 4
Knowledge on initiatives related to climate change and health among the study participants (n = 3062).

Name of initiative	ASHA workers (%)	Doctors (%)	Hospital administrators (%)	Nurses (%)	Paramedical staff (%)	Public health professionals (%)	Healthcare students (%)	TOTAL n = 3062 (%) (95% CI)
Climate action plan developed by MoHFW	72.1	64.5	71.0	76.5	82.6	77.7	63.5	72.6 (71.0, 74.2)
Air pollution monitoring and action plan	70.2	89.2	58.0	67.5	64.8	57.6	75.3	68.9 (67.3, 70.5)
Green hospitals initiative	60.1	83.5	68.6	68.5	64.3	63.9	70.3	68.5 (66.9, 70.1)
Heat action plan	43.5	66.1	34.1	40.2	46.7	33.4	40.8	43.5 (41.8, 45.2)

climate-induced migration (56.0%) were comparatively lower (table II available in the Appendix).

3.2. Attitudes about climate change and health

Most of the participants reported interest to learn more about linkages between infectious disease outbreaks and climate change (72.7%), and to improve energy efficiency and install clean, renewable energy generation at their healthcare facilities (58.2%). A smaller proportion of respondents were interested to learn more about the role of the healthcare workforce in the context of climate change (43.9%, higher among doctors at 52.7%). Among the seven streams of healthcare workforce, only the doctors had more than half the respondents expressing interest to learn and address climate change and its health effects (Table 5).

It was generally felt by the respondents that they had a responsibility to address climate change (85.6%), and also that the healthcare sector contributes to climate change (80.3%). Most of the respondents also agreed that the healthcare sector – both infrastructure and the workforce – are directly impacted by climate change (69.2%), and that healthcare professionals should be actively raising awareness on the issue of climate change and its health effects among the public (86.8%). It was also felt that climate change and its health effects should be included as a subject in healthcare curricula (72.6%) (table III available in the Appendix).

3.3. Practice - measures being undertaken to address climate change and its health impacts

The majority of the respondents have taken measures to address climate change and its health impacts. For instance, over half of them have discussed it with their colleagues (55.5%). Several of them had also participated in air pollution-related campaigns (57.4%). A large proportion of nurses (52.2%) and ASHAs (40.1%) reported having already participated in climate change-related campaigns. A high

Table 5
Interest of the study participants in learning about and addressing climate change and its health effects (n = 3062).

Variables	ASHA workers (%)	Doctors (%)	Hospital administrators (%)	Nurses (%)	Paramedical staff (%)	Public health professionals (%)	Healthcare students (%)	TOTAL n = 3062 (%) (95% CI)
To know more about the linkages between infectious disease outbreaks and climate change	66.3	81.2	71.0	71.5	68.4	75.5	75.1	72.7 (71.1, 74.2)
To implement energy efficiency and clean, renewable energy generation at their healthcare facilities	53.6	67.1	50.1	62.9	57.3	48.1	68.1	58.2 (56.4, 59.9)
To know more about impacts of climate change on health infrastructure	54.3	61.2	56.6	61.8	55.3	48.9	57.6	56.5 (54.7, 58.2)
To support green and healthy hospital design and construction	51.4	61.6	48.5	68.5	59.4	37.8	68.3	56.5 (54.7, 58.2)
To purchase and serve sustainably grown, healthy food	48.3	59.2	39.6	55.4	49.2	38.0	60.9	50.1 (48.3, 51.8)
To know more about the role of Government	53.6	58.4	42.8	49.6	44.7	38.3	53.9	48.8 (47.0, 50.5)
To know more about the role of health professionals and workers	36.3	52.7	37.7	41.8	44.2	44.8	49.8	43.9 (42.1, 45.6)

Table 6
Proportion of study participants who have taken measures regarding climate change and its health effects (n = 3062).

Variables	ASHA workers (%)	Doctors (%)	Hospital administration (%)	Nurses (%)	Paramedical Staff (%)	Public health professionals (%)	Healthcare students (%)	TOTAL n = 3062 (%) (95% CI)
Discussed about CC and its health effects with my colleagues	49.8	43.9	53.4	53.8	38.6	47.3	65.5	55.5 (53.7, 57.2)
Involved in the CC related awareness campaigns	40.1	34.7	44.4	52.2	30.5	36.4	56.6	56.5 (54.6, 58.2)
Involved in air pollution related awareness campaigns	37	36.9	40.9	47.8	28.9	39.4	54.4	57.4 (55.6, 59.2)
Educated the healthcare facility to adopt renewable energy sources	40.9	35.9	41.7	47.4	25.7	32.3	52.8	58.4 (56.6, 60.1)

Table 7
Main source of information on climate change and health among study participants.

Source of information on climate change	ASHA workers (%)	Doctors (%)	Hospital administrators (%)	Nurses (%)	Paramedical staff (%)	Public health professionals (%)	Healthcare students(%)	TOTAL n = 3062 (%) (95% CI)
Newspaper	30.3	22.0	37.7	33.9	29.3	24.5	22.1	28.2 (26.6, 29.7)
Television	30.0	22.7	31.7	24.3	28.2	22.8	21.2	25.8 (24.2, 27.3)
Social Media	10.1	16.3	19.0	21.7	18.5	10.9	30.3	18.1 (16.7, 19.4)
Personal involvement	5.5	22.5	2.7	7.6	3.4	0.0	3.1	6.4 (5.5, 7.2)
Textbooks/ Journals	3.8	8.2	1.9	2.8	5.0	2.4	15.7	5.6 (4.8, 6.4)
Public health professionals	2.9	2.7	0.5	0.4	1.4	26.4	0.2	4.9 (4.1, 5.6)
Websites/Online	4.1	4.1	2.4	2.2	1.4	6.8	4.8	3.6 (2.9, 4.2)
WhatsApp	5.5	0.4	4.1	3.6	8.8	1.6	1.1	3.5 (2.8, 4.1)
Radio	7.0	0.2	0.0	1.4	0.5	2.4	0.7	1.7 (1.2, 2.1)
Weekly Magazine	0.7	0.8	0.0	2.0	3.6	2.2	0.9	1.4 (0.9, 1.8)

rate of involvement in activities related to climate change was also noticed among healthcare students (Table 6).

Most of the study participants indicated that improving emergency care (93.5%), better patient care facilities (93.2%) and regular supply of medicines and kits (93.2%), Early Warning Systems (91.1%), regular supply of water (90.9%), better coordination among departments (90.4%), regular supply of electricity (89.8%), and better building infrastructure (89.6%) are needed to deal with future climate change impacts (table IV available in the Appendix).

3.4. Preferred educational media and material

Newspapers (28.2%), television (25.8%) and social media (18.1%) served as the main source of information on climate change and health for the respondents. There were also some variations between the sub-groups, for instance, for a sizable proportion of the doctors (22.5%) it was attending trainings ("personal involvement") that played a significant role in gaining a basic understanding, whereas for ASHAs it was mainly newspapers (30.3%) and television (30.0%). Similarly, for 21.7% of the nurses and 30.3% of the medical students it was social media, and for 26.4% of the public health professionals, it was colleagues in their networks that served as the main source of information on climate change and health (Table 7).

For future communications on climate change and health, material in color (72.4%) was preferred over black and white (55.2%). Posters (66.1%) and reports (65.4%) were more preferred than brochures (57.5%) and leaflets (52.6%). Content using images and pictures (77.8%) were preferred. While ASHAs (77.4%), doctors (74.3%) and hospital administrators (73.4%) preferred communication in the English language, other streams preferred material in their local/ regional languages. Newspapers (82.0%) and social media (64.0%) were more preferred over Radio (38.5%) (table V available in the Appendix).

4. Discussion

With limited literature available on knowledge, attitudes and practices of the healthcare workforce regarding climate change and health in India, this study is the first of its kind. Our questionnaire was more exhaustive in terms of climate hazards, health effects and other aspects related to attitudes and practices, but we selected few of the indicators from each section of the questionnaire that we felt adequately conveyed relevant insights on the KAP of participants within the scope of a journal article.

4.1. Interpreting the results on "knowledge"

The intermediate or delayed health impacts of climate change such as allergies and malnutrition were relatively less often identified as potential health impacts of climate change. Perhaps these impacts are more invisible as compared to the impacts of extreme weather events. Similar findings were reported from a survey from China where higher awareness about heat- (92.8%) and cold-related illness (88.8%) as compared to mental impacts (63.7%) were reported [20]. Following a similar pattern, the majority of the participants were aware of climate change manifestations such as floods, droughts, cyclones, forest fires, change in rainfall pattern and sea level rise, but only half of the participants were aware of climate-induced migration (56.0%) and social conflicts (49.7%) as manifestations. The latter impacts are not 'direct', but mediated through social and economic pathways [39], which may explain the finding. Similar results were reported from a multinational study conducted in 2020, where only a

minority of the respondents were aware of violence, conflicts or resulting dislocation (36%) as potential impacts [25].

4.2. Interpreting the results on attitudes

Most of the respondents believed that the healthcare sector also contributes to climate change (80.8%) and has a responsibility to address climate change (85.4%). Another multinational study among health professionals reported that 86% respondents felt that health professionals have a responsibility to bring the health effects of climate change to the attention of the public [25]. Majority of our study participants opined that healthcare workers should take necessary steps to reduce the impacts of climate change (81.5%). Similar finding was reported in a study conducted at Yale University, USA where nearly 90% of health professionals agreed that they have responsibility to conserve resources and prevent pollution in their workplace [40]. These results are encouraging, as it shows that the health sector has the potential to participate in addressing climate change and its health effects.

4.3. Interpreting the results on practices and preparedness

There was a high level of awareness on official action plans [41] towards air pollution monitoring and mitigation (69.9%). The National Programme on Climate Change and Human health (NPCCHH) and the National center for Disease Control (NCDC) have conducted workshops and programmes on air pollution, and a program on climate change and health for ASHAs, nurses, and program coordinators, among others [42]. The NPCCHH has also prepared material in English and regional languages for display in healthcare facilities. These points can help explain the findings, especially as most respondents (71.3%) were from the government sector, and these interventions were initiated by the government just around the time of the survey.

Regarding our findings on air pollution and health, the frequent coverage on this topic in the media since the last few years may explain this particular finding. Compared to this, the awareness on heat action plans was lower across the groups (44.4%). This could be because not all the states in India have formulated heat action plans (Chhattisgarh and Meghalaya, for instance), in accordance with the local vulnerability to this specific hazard. Currently, the national government is drafting and implementing the heat action plans for 100 cities in 23 states across the country [43]. Finally, our findings on the preferred format of educational materials will be useful for developing group-specific strategies.

Overall, it is important to report that our geographical focus was India, and hence aggregate results were presented. However, subgroup analysis of prevalence of KAP at state-level for the six states covered in the study found wide variation between states (and between specific categories of healthcare workers between states). This is potentially indicative of the differences in the relevant programmatic interventions that have already taken place in that state, and also provides insights of the local level planning needed for additional programmatic interventions on climate change and health in that state.

4.4. Limitations of the study

Healthcare professionals/workers being very busy with COVID duties, our response rate was 55.4%. While the sample size was met, it was not a random sample. Efforts were made to improve the representativeness of the sample through measures such as selecting different districts and approaching several networks and associations. Though all potential respondents were encouraged to participate, selection bias can be expected, for instance, with those who are more interested in climate change and health being more likely to answer the survey. This may be one reason for the relatively high proportions of affirmative responses across the board.

Another explanation for these results could be the close-ended questions. This may have especially impacted the results of the knowledge-related questions, leading to higher estimates. Social desirability bias may have affected the responses to the questions on attitudes (interest to learn and do more), leading to higher estimates for the prevalence of positive attitudes to learn and do more on climate change and health. The practice-related questions also may have been interpreted in a broad sense (awareness-raising and institutional advocacy), leading to higher proportions of affirmative responses. Qualitative studies with participants providing these responses would help to clarify them.

Also, questionnaires were administered in three modalities: telephonic, in-person, and online, to improve response rate. This has not been accounted for in the analysis, as data on the modality were not available. It is possible that modalities have affected the responses, especially those conducted in person may have been affected by social desirability bias.

An important limitation of this study is that it did not explore the perception among respondents on the health vulnerability of socially marginalised groups, ethnic minorities/indigenous communities, and people with pre-existing health conditions to climate change. We only explored perceived vulnerability in terms of age and gender. Those dimensions of vulnerability are also critically important and contextually relevant.

As the majority of the study participants were from the public sector, the generalization of the results to the private sector healthcare professionals would be inappropriate. This is due to differential exposure to training and various government initiatives on climate change and human health.

4.5. Implications of the study

Our findings showed that 43% of our respondents are interested to learn more about their role to address climate change and its health effects, which is encouraging for interventions in that direction. We inferred about the need to sensitize the healthcare workforce about the indirect impacts of climate change on health, such as malnutrition and mental health effects, keeping in mind the relatively low awareness on these aspects. It was also interesting to observe students reporting relative awareness about the subject and an interest to learn, which may be due to the increased activism in social media on these issues, indicating that the time is ripe for developing curriculum content on this subject. The relatively high prevalence of knowledge among community-based health workers (ASHA and ANMs) was also encouraging, as they will be at the frontlines – experiencing and managing the effects. We imagine knowledge and action will only increase with time due to governmental programmes, NGO interventions and the increasingly visible impacts of the changing climate. We were also able to identify the preferred type of communication materials for each section of the health workforce, which would be useful for planning interventions. However, any planned interventions should be cognisant of the type of work that each sub-group of the health workforce undertake, and also the existing workloads.

Based on the information obtained through this study, we have created a communication guide on climate change and health titled ‘No Vaccine for Climate Change’ to equip healthcare professionals to converse about the health effects of climate change with patients, communities, media persons, policymakers and professional peers [44]. The communication guide has been adopted by the Government of Kerala (a state in India) and will be released in the local language to serve as a resource for training for health workers in the state. The document will also be translated into two other regional languages in other states in India.

There is a need for further qualitative and mixed method studies to understand the motivations and challenges faced by health workers to understand about and address climate change and its health effects, and also with the private healthcare sector that was not covered adequately as part of our study. The governmental healthcare workforce in India is already stretched with several duties, especially due to severe shortage of staff in several places [45]. In that context, the interest to learn about and address climate change and health may be low among some sections of the healthcare workforce. In addition, it would be useful to conduct operational research and intervention research to study the effectiveness of the communication tools and training efforts for the healthcare workforce.

Our methods and findings may also be relevant to contexts in South East Asia, Africa and Latin America, where populations are disproportionately vulnerable to climate change and the health sector is relatively weak but with various cadres of healthcare workers making efforts to address health challenges at different levels.

5. Conclusion

Our study reported the prevalence of various aspects on the KAP related to climate change and health among the healthcare workforce in India. Overall, the proportion of respondents reporting knowledge, interest in learning and doing more, and involvement in addressing health effects of climate change were high. Our study suggests that the time is ripe for building competence in the area of climate change and health among the healthcare workforce in India. Suitable media for each subgroup of the workforce, ranging from newspapers to social media, were also identified. However, any educational and other interventions should consider the existing burden of work faced by the health workers, and so there is benefit for additional research keeping in mind the specific roles of each subgroup of the healthcare workforce.

Contributing 4.4% to the global net GHG emissions [46], and being on the frontline for the impacts of climate change, the healthcare sector has both a responsibility and an opportunity to build healthy and resilient communities. The Government of India has integrated the health mission with other missions under National Action Plan on Climate Change (NAPCC) to address climate-sensitive diseases. Strengthening the capacity of healthcare workforce on climate change and its health effects is imminent [47], so that informed actions can be taken towards managing these challenges [48]. Health effects and health sector preparedness is gaining priority in the climate change narrative in many countries across the globe, and our study presented the current situation in India, and demonstrated an approach (and also the challenges) to gauge the KAP situation among the healthcare workforce at the country-level in other countries.

Credit author statement

Vishvaja Sambath: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Resources, Validation, Visualization, Roles/Writing - original draft, Writing - review & editing.

Shweta Narayan: Conceptualization, Methodology, Project administration and Resources.

Punita Kumar: Project administration and Resources

Pooja Kumar: Methodology and Resources

Adithya Pradyumna: Formal analysis, Methodology, Visualization, and Writing - review & editing.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Healthy Energy Initiative - India is a campaign of Health Care Without Harm (HCWH), an international nongovernmental organization (NGO) that works to transform health care worldwide so that it reduces its environmental footprint, becomes a community anchor for sustainability, and a leader in the global movement for environmental health and justice. Climate and Health is one of the key areas where HCWH works.

CRediT authorship contribution statement

Vishvaja Sambath: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. **Shweta Narayan:** Conceptualization, Methodology, Project administration, Resources. **Punita Kumar:** Project administration, Resources. **Pooja Kumar:** Methodology, Resources. **Adithya Pradyumna:** Formal analysis, Methodology, Visualization, Writing – review & editing.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.joclim.2022.100147.

Appendix

Tables I–V

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Table I
Knowledge on causes for climate change among the study participants (n = 3062).

Causes/Reasons for climate change	ASHA workers (%)	Doctors (%)	Hospital administrators (%)	Nurses (%)	Paramedical staff (%)	Public health professionals (%)	Healthcare students (%)	Total n =3062 (%) (95% CI)
Deforestation	92.8	96.9	93.5	89.2	92.6	88.9	94.1	92.6 (91.6, 93.5)
Burning Fossil Fuel	86.8	88.0	87.5	80.3	81.7	85.1	87.6	85.3 (83.9, 86.5)
Solid Waste	85.1	82.4	89.7	77.3	84.4	82.6	89.3	84.4 (83.1,85.7)
Population Growth	76.4	92.0	85.9	82.7	80.1	76.9	89.3	83.3 (82.0, 84.7)
Industrial Activities	86.3	83.9	84.3	77.5	80.4	79.3	84.9	82.4 (81.0, 83.7)
Transport	79.1	86.7	80.8	76.3	75.6	77.7	79.7	79.4 (78.0, 80.8)
Buildings	74.8	72.9	77.0	71.9	79.2	76.9	74.9	75.4 (73.8, 77.0)
Agricultural Activities	73.6	73.5	76.2	70.1	74.3	75.0	71.2	73.4 (71.8, 75.0)
Increase in Livestock Farming	48.8	56.1	40.4	41.2	37.2	31.3	44.5	42.8 (41.0, 44.6)
God's Will	18.5	8.2	11.7	23.1	15.1	15.8	12.7	15.0 (13.8,16.3)

Table II
Knowledge on impacts of climate change among the study participants (n = 3062).

Impacts of climate change	ASHA workers (%)	Doctors (%)	Hospital administrators (%)	Nurses (%)	Paramedical staff (%)	Public health professionals (%)	Healthcare students (%)	Total n = 3062 (%) (95% CI)
Change in rainfall pattern in the last 10 years	85.6	81.0	86.4	79.5	76.1	78.8	87.8	82.2 (80.8, 83.5)
Increased floods and cyclones in the last 10 years	87.7	92.0	81.6	78.1	73.1	78.3	78.8	81.4 (80.0, 82.8)
Increased health care expenditure after extreme weather events	73.6	86.5	84.3	78.3	76.3	75.3	81.7	79.4 (77.9, 80.8)
Increase in cases of mental illness – depression, anxiety, suicides etc	72.4	84.9	74.0	77.1	64.3	75.5	79.3	75.4 (73.8, 76.9)
Increased forest fires in the last 10 years	82.2	78.2	73.7	71.7	67.3	73.4	76.6	74.7 (73.1, 76.2)
Increase in cases of new types of diseases	73.3	89.0	66.9	75.7	64.1	55.7	88.0	73.2 (71.7, 74.8)
Increased drought in the last 10 years	80.3	75.3	77.0	65.9	64.6	70.4	78.2	73.1 (71.5, 74.7)
Death from Disease carrying Vectors – Malaria, Dengue, Chikungunya etc	66.3	76.1	70.5	68.1	69.3	73.4	73.6	71.0 (69.4, 72.6)
Change in sea water level in the last 10 years	79.1	68.2	68.3	66.7	66.1	71.7	70.7	70.1 (68.5, 71.7)
Reduced food crop production in the last 10 years	75.0	69.0	67.8	70.1	65.7	68.2	67.7	69.1 (67.4, 70.7)
Increased health risk due to increase in salinity	65.1	68.2	57.7	71.5	58.5	65.2	62.2	64.0 (62.3, 65.7)
Increase in cases of allergies	63.7	82.9	53.9	68.9	58.5	45.4	74.7	64.0 (62.3, 65.7)
Increased salinity of freshwater and/or groundwater in the last 10 years	57.5	60.6	52.3	54.8	54.6	68.8	56.3	57.8 (56.1, 59.6)
Increase climate induced migration	51.2	54.1	52.0	61.2	49.7	52.4	71.0	56.0 (54.2, 57.7)
Scarcity of fresh water due to increase in salinity	53.1	60.2	42.0	56.2	48.3	44.8	57.6	51.7 (49.9, 53.5)
Death from drowning in the last 10 years	52.9	43.1	41.2	43.2	39.3	42.4	45.2	43.9 (42.1, 45.7)
Death from snake bite in the last 10 years	36.1	30.4	22.5	29.1	25.3	31.0	30.8	29.3 (27.7, 31.0)

Table III
Knowledge on the role of Healthcare Sector and Professionals in Climate Change among the study participants (n = 3062).

Role of Health sector in climate change	ASHA workers (%)	Doctors (%)	Hospital administrators (%)	Nurses (%)	Paramedical staff (%)	Public health professionals (%)	Healthcare students (%)	Total n = 3062 (%) (95% CI)
Health care professionals to raise awareness on climate change and its impacts amongst the public	88.9	83.9	81.6	85.3	86.5	92.9	88.6	86.8 (85.6, 88.0)
Responsibility of health sector to address climate change	84.9	78.4	83.2	85.7	86.9	90.5	89.7	85.6 (84.3, 86.9)
Need to build healthcare systems that can withstand extreme climatic events	79.8	78.0	79.7	80.7	84.4	89.1	88.9	82.9 (81.6, 84.3)
Make biomedical rules more stringent	88.2	86.1	86.7	78.1	69.1	77.2	88.4	82.0 (80.6, 83.3)
Take steps by healthcare workforce to reduce the impact of climate change	77.9	76.1	83.2	76.3	79.0	92.7	88.4	81.9 (80.5, 83.2)
Increasing the burden on health care professionals due to climate change	69.2	79.8	81.0	69.3	67.3	72.0	78.2	73.8 (72.2, 75.4)
Awareness on Ministry of Health and Family Welfare's climate action plan to mitigate the impact of Climate Change on Human Health	61.1	58.8	64.8	72.3	93.7	89.4	69.4	72.8 (71.2, 74.4)
Climate change should be included in the curriculum of medical education	82.5	77.8	82.4	77.1	46.7	60.3	81.2	72.6 (70.9, 74.1)
Need for make healthcare systems to reduce their own carbon footprint	78.4	72.4	74.5	71.1	48.3	73.4	86.7	72.1 (70.5, 73.7)
Impact on health care professionals and/or infrastructure by climate change	68.3	67.5	72.9	72.7	67.0	76.6	59.6	69.2 (67.6, 70.9)

Table IV
Preference of study participants on the improvements to be made in the health infrastructures to cope with climate change related issues (n = 3062).

Improvements to be made in the health infrastructure	ASHA workers (%)	Doctors (%)	Hospital administrators (%)	Nurses (%)	Paramedical staff (%)	Public health professionals (%)	Healthcare students (%)	Total n = 3062 (%) (95% CI)
Better emergency care	94.0	88.0	92.7	95.6	92.8	94.0	97.4	93.5 (92.6, 94.3)
Better patient care facilities	95.4	89.6	94.0	95.2	86.5	94.8	97.2	93.2 (92.3, 94.1)
Regular supply of medicines and PPE Kits	95.0	88.0	91.1	92.6	93.7	94.6	97.4	93.2 (92.3, 94.1)
Early warning systems about the diseases	94.2	86.5	89.2	85.7	92.8	92.4	96.9	91.1 (90.0, 92.1)
Regular supply of water	94.2	86.9	91.6	79.7	93.0	94.0	97.2	90.9 (89.9, 91.9)
Better coordination among departments	95.0	86.9	89.4	77.5	93.2	93.5	97.6	90.4 (89.3, 91.4)
Regular supply of electricity	94.0	85.7	88.6	79.1	94.1	91.8	95.6	89.8 (88.7, 90.9)
Better Building infrastructure	93.5	83.5	89.4	76.7	92.3	95.7	96.1	89.6 (88.5, 90.7)

Table V
Preferences regarding climate change and health related communications among the study participants (n = 3062).

communication preferences	ASHA workers (%)	Doctors (%)	Hospital Administrators (%)	Nurses (%)	Paramedical Staff (%)	Public Health Professionals (%)	Healthcare Students (%)	total n = 3062 (%) (95% CI)
color of the communication material								
color	70.9	63.1	74.5	68.3	73.1	77.2	79.5	72.4 (70.8, 73.9)
Black & White	42.5	48.8	44.2	66.1	53.7	67.9	63.3	55.2 (53.4, 57.0)
Format of the communication material								
Poster	72.4	63.7	70.2	63.9	62.1	67.7	62.9	66.1 (64.4, 67.8)
Report	76.2	61.6	68.3	76.9	50.1	54.1	71.0	65.4 (63.7, 67.1)
Scientific Articles	68.3	72.7	66.1	52.2	32.7	56.5	67.0	59.4 (57.6, 61.1)
Feature stories	63.9	64.9	64.5	50.8	37.2	64.1	67.9	59.0 (57.3, 60.8)
Brochure	48.6	51.4	45.5	60.4	65.7	65.8	65.3	57.5 (55.8, 59.3)
Leaflet	51.7	48.4	56.1	47.2	49.9	56.8	58.1	52.6 (50.8, 54.4)
Format of the content in the communication material								
Photographs	88.0	81.4	82.7	83.7	55.5	79.6	73.4	77.8 (76.2, 79.2)
Illustrations	71.6	67.5	72.9	55.2	66.4	82.1	75.5	70.2 (68.5, 71.8)
Language of the communication material								
Local Language/ Mother tongue	62.7	67.1	68.6	94.8	84.9	82.3	89.5	78.5 (77.0, 80.0)
English	77.4	74.3	73.4	35.5	45.8	72.0	53.5	61.7 (59.9, 63.4)
Hindi	50.7	43.9	62.1	53.8	88.9	63.6	54.6	59.7 (57.9, 61.4)
Medium of the communication material								
Newspaper	86.5	74.5	84.6	64.1	85.3	90.8	88.0	82.0 (80.6, 83.3)
Social Media like Facebook and Twitter	65.9	73.3	69.9	60.4	46.0	66.8	65.5	64.0 (62.2, 65.7)
WhatsApp	65.1	70.2	69.6	77.5	30.9	56.0	55.5	60.7 (58.9, 62.4)
Radio	28.6	38.8	30.6	26.7	37.5	48.1	59.0	38.5 (36.7, 40.2)