Research priorities in Maternal, Newborn, & Child Health & Nutrition for India

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Research Priorities in Maternal, Newborn, & Child Health & Nutrition for India: An Indian Council of Medical Research-INCLEN Initiative

Narendra K. Arora[1], Soumya Swaminathan[2], Archisman Mohapatra[1], Hema S. Gopalan[1], Vishwa M. Katoch[2], Maharaj K. Bhan[3], Reeta Rasaily[2], Chander Shekhar[2], Vasantha Thavaraj[2], Malabika Roy[2], Manoja K. Das[1], Kerri Wazny[15], Rakesh Kumar[2], Ajay Khera[4], Neerja Bhatla[5], Vanita Jain[11], Avula Laxmaiah[12], M.K.C. Nair[13], Vinod K. Paul[6], Prema Ramachandran[7], Siddharth Ramji[8], Umesh Vaidya[14], I.C. Verma[9], Dheeraj Shah[10], Rajiv Bahl[16], Shamim Qazi[16], Igor Rudan[15], Robert E. Black[17] & for the ICMR INCLEN Research Priority Setting Network[18]

[1]Executive Office, The INCLEN Trust International, [2]Headquarters, Indian Council of Medical Research, [3]Centre for Health Research and Development (CHRD), Society for Applied Studies, [4]Department of Health and Family Welfare, Ministry of Health and Family Welfare, Government of India, Departments of [5]Obstetrics and Gynaecology, [6]Pediatrics, All India Institute of Medical Sciences, [7]Nutrition Foundation of India, [8]Department of Neonatology, Maulana Azad Medical College, [9]Editorial Office, Indian Journal of Pediatrics, [10]Editorial Office, Indian Pediatrics, New Delhi, [11]Department of Obstetrics and Gynaecology, Postgraduate Institute of Medical Education and Research, Chandigarh, [12]Division of Community Studies, National Institute of Nutrition, Hyderabad, [13]Office of the Vice Chancellor, Kerala University of Health Sciences, Thrissur, [14]Department of Pediatrics, KEM Hospital, Pune, India, [15]Centre for Global Health Research, Usher Institute for Population Health Sciences and Informatics, University of Edinburgh, Edinburgh, UK, [16]Department of Maternal, Newborn, Child and Adolescent Health, World Health Organization, Geneva, Switzerland, [17]Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA, [18]India (Names arranged alphabetically according to City and Author Surname)

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In India, research prioritization in Maternal, Newborn, and Child Health and Nutrition (MNCHN) themes has traditionally involved only a handful of experts mostly from major cities. The Indian Council of Medical Research (ICMR)-INCLEN collaboration undertook a nationwide exercise engaging faculty from 256 institutions to identify top research priorities in the MNCHN themes for 2016-2025. The Child Health and Nutrition Research Initiative method of priority setting was adapted. The context of the exercise was defined by a National Steering Group (NSG) and guided by four Thematic Research Subcommittees. Research ideas were pooled from 498 experts located in different parts of India, iteratively consolidated into research options, scored by 893 experts against five pre-defined criteria (answerability, relevance, equity, investment and innovation) and weighed by a larger reference group. Ranked lists of priorities were generated for each of the four themes at national and three subnational (regional) levels [Empowered Action Group & North-Eastern States, Southern and Western States, & Northern States (including West Bengal)]. Research priorities differed between regions and from overall

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national priorities. Delivery domain of research which included implementation research constituted about 70 per cent of the top ten research options under all four themes. The results were endorsed in the NSG meeting. There was unanimity that the research priorities should be considered by different governmental and non-governmental agencies for investment with prioritization on implementation research and issues cutting across themes.

Key words Child health - Child Health & Nutrition Research Initiative - Indian Council of Medical Research - INCLEN - maternal health - Maternal, Newborn, and Child Health and Nutrition - newborn health - nutrition - research priority setting

National Steering Group[18]

Reang Kamal, Agartala; Mavalankar Dileep, Ahmedabad; Nandan Deoki (Late), Allahabad; Dhanya Kumar BN, Divakar Hema, Rao Veena S, Bengaluru; Sivadas Aswathi, Bhubaneswar; Jain Vanita, Chandigarh; Bansal Pankaj K, Iyyanar N, Chennai; Dholakia NB, Gandhinagar; C Sarala Rajyalakshmi, Guntur; Bhatnagar Shinjini, Chandy Thomas, Sharma Rekha, Reddy KS, Zodpey Sanjay, Gurugram; Deka Hitesh, Guwahati; Bansal CP, Gwalior; Laxmaiah A, Hyderabad; Prasad Nupur, Jaipur; Bhatti MH, Jammu; Awasthi Shally, Lucknow; Bavdekar Sandeep, Begkoyian Genevieve, Krishna Vandana, Mumbai; Purwar Manorama, Nagpur; Arora NK, Arora Rashmi, Awin Narimah, Bagchi Kunal, Baswal Dinesh, Bhan MK, Bhatla Neerja, Bhushan Himanshu, Chaturvedi Sanjay, Chaudhury RR (Late), Chopra Nandita, d'Silva Angela, Das JK, Dasgupta Rajib, Deb Sila, Desiraju Keshav, Dhamija NK, Francis Paul, Elliott Marshall, Goswami Kiran, Gupta Anuradha, Gupta Piyush, Haldar Pradeep, Vijay Raghavan K, Kannan Evelyn P, Kant Lalit, Kapil Umesh, Kathuria Ashi, Katoch VM, Khera Ajay, Kiran Usha, Kriplani Alka, Kumar Harish, Kumar Rajesh, Kumar Rakesh, Kumar Sanjiv, Malhotra Manisha, Mathur Prashant, Mehta Jayshree, Mehta Rajesh, Mishra CK, Mor Nachiket, Mozo Victor A, Mundol Hisham, Mukherjee Shirshendu, Narain Prem, Patwari Ashok K, Paul Vinod K, Prabhakar PK, Pradhan Anju, Prasad Jagdish, Rai Sanjay K, Raina Neena, Ramachandran Prema, Ramji Siddharth, Rasaily Reeta, Rathore AS, Roy Malabika, Sankar Rajan, Seda Sheila, Seem Tarun, Shah Dheeraj, Sharma Ashutosh, Sharma Bhanu P, Shreeranjan, Sidhwa Xerses, Singh Gayatri, Singh Lakhwinder P, Singh Shalini, Sood Bulbul, Swaminathan Soumya, Ramasami T, Talwar KK, Tandon Rajiv, Thavaraj Vasantha, Toteja GS, V Somasundaran, Verma IC, New Delhi; Kumar Sanjay, Patna; Jog Pramod, Pune; Amandeep Garg, Shimla; Subba Namita H, Sikkim; K Rajamohanan, Nair MKC, Prathapan P, Thiruvananthapuram.

Research Sub-Committee[18]

Visaria Leela, Ahmedabad; Maitra Nandita, Baroda; Kodkany BS, Belagavi; Kurpad Anura V, Murthy Nirmala, Raj Rebecca K, Bengaluru; Dwivedi Rashmi, Kanani Shubhada J, Bhopal; Mohanty Aswini, Bhubaneswar; Nahrel Rakesh, Bilaspur; Jana Narayan, Burdwan; Singh Karanjit, Chandigarh; Kumar Rathna, Vijayakumar, Chennai; Kowsalya S, Coimbatore; Kumar Ashok, Darbhanga; Pradhan PM, Gangtok; Agarwal Veena, Gwalior; Prakasamma M, Shamanna BR, Hyderabad; Sharma Yashpal, Jammu; Baroovah Basanti, Jorhat; Prabhu Radhabai, Kancheepuram; Das Indranil, Kolkata; Das Vinita, Hashmi Gulfam, Jain Neera, Srivastava Niraj M, Lucknow; Chhatwal Jugesh, Ludhiana; Gupta Abhilasha, Meerut; K Sheela, Meghalaya; Daver Rekha G, Dwivedi Laxmi K, Madan Jagmeet, Mumbai; Patel Archana B, Mundle Shuchita, Nagpur; Agarwal Ramesh K, Anand VK, Bhandari Nita, Chowdhury Dipa N, Chhabra Sheena, Das Abhijit, Deka Deepika, Dubey AP, Ghosh D, Ghosh Sandip, Gogoi Aprajita, Jain Shikhar, Kalaivani K, Khan ME, Khanna Rajesh, Kumar Sanjiv, Malhotra Sudhansh, Malhotra Sunita, Mathai Saramma T, Mathur Arvind, Menon Purnima, Puri Seema, Sagar Karan S, Tripathi Reva, Singh Arun K, Vir Sheila C, New Delhi; Jampa Lobsang, Papum Pare; Kumar Sanjay, Patna; Bhat B Vishnu, Chathurvedula Latha, Srinivasan S, Puducherry; Vaidya Umesh, Pune; Daripa Tapan K, Raipur; Pandey Sharat, Sharma Arun K, Ranchi; Abraham Alice, Shillong; Bhat Sharif, Srinagar; Krishnaswamy Kamala, Hyderabad; Chandran Anil, Jain Naveen, Elizabeth KE, Remadevi S, Thiruvananthapuram; Iyenger Kirti, Udaipur.

Nation-wide Network[18]

Names of participants in the Nation-wide Network are provided in Supplementary Table I (available on *http://www.ijmr.org.in/articles/2017/145/5/images/IndianJMedRes_2017_145_5_611_215547_sm6.pdf*) and also on *www.inclentrust.org*

Prioritization of research options in health is essential to plan for achieving efficient and impactful investment of limited resources against a large number of competing research options[1]. There is an increasing need and effort to set research priorities in health in a systematic way using a sound and transparent methodology and through engagement of the various key stakeholder constituencies[2,3]. Research priority setting (RPS) in India has traditionally been guided by a small group of experts, mostly identified from major metropolitan areas of the country. Subsequent to India's impressive yet inadequate improvement towards achieving Millennium Development Goals (MDGs) 1, 4 and 5, an expert group had convened on May 23, 2011 at the Indian Council of Medical Research (ICMR) Headquarters in New Delhi to discuss RPS. The participants observed that evidentiary gaps in the country impeded informed action in Maternal, Newborn, and Child Health and Nutrition (MNCHN) themes, and that an inclusive and transparent method should be adopted to decide the national research agenda. The agenda so developed should also identify areas for innovation and strategies to improve deliverability, efficiency, scalability and sustainability of existing interventions, avoid common blind spots in MNCHN research (*e.g*., still birth & neonatal health) and engage the multiple stakeholder constituencies including end users of any funded health research activity. This led to the formalization of the ICMR-INCLEN collaboration for undertaking the national RPS exercise for MNCHN using the Child Health and Nutrition Research Initiative (CHNRI) methodology. Since 2006-2007, the CHNRI priority setting methodology has been increasingly acknowledged as a flexible yet systematic priority-setting method for ranking competing research options using an objective, quantified and inclusive approach[2-7]. The method is opined to be effective at the national level where the results derived from inputs from national stakeholders can have a direct and prominent impact on the research investment policy[8]. As a major conceptual advancement, this method ranks the broadly defined competing research options that not only generate new knowledge but also synthesize evidence for efficient implementation of what is already known[9]. The ranking of these research options employs 'crowdsourcing' through the engagement of a wide range of stakeholder constituencies with due cognizance of their core expertise. The various dimensions of the research priorities are carefully examined by the experts using a predefined context and set of strictly defined scoring criteria. The collective optimism of the stakeholders, which can be considered as the 'wisdom of the crowd', helps in identifying research priorities through a democratic method of scoring, weighting and ranking of competing research options[1,5].

National Research Priority Setting (RPS) exercise for Maternal, Newborn, and Child Health and Nutrition (MNCHN)

The protocol was reviewed and approved by the Independent Institutional Ethics Committee of INCLEN, and the exercise was undertaken between 2012 and 2016. The context, in which the research priorities were identified in this exercise, are provided in Box 1.

The exercise was woven around four key structures, namely, the National Steering Group (NSG), the Thematic Research Subcommittees (RSCs) constituted for each of the four MNCHN themes (112 experts in India were identified based on active contribution to contemporary research), the Nation-wide Network for Crowdsourcing (experts of various disciplines related to MNCHN with due attention to regional representation

Box 1. Context of the Indian Council of Medical Research-International Clinical Epidemiology Network (ICMR-INCLEN) National Research Priority Setting Exercise for maternal, newborn, child health and nutrition

Purpose: Priority setting in maternal, newborn, and child health and nutrition for efficient and rewarding investment in research using a systematic, transparent, inclusive and consultative method.

Geography: India (National) and three regional levels *viz*., Empowered Action Group (EAG) & North-Eastern States, Southern & Western States, and Northern States & West Bengal.

Target population: Women of reproductive age (15-49 yr); pregnant women, newborns (0-28 days), under-five children (0-59 months) and children (up to the age of 18 yr).

Major areas of concern for research: Conditions that together contributed to at least 75% of the mortality and morbidity burden in Maternal, Newborn, Child Health and Nutrition in India during 2012-2013 as per the available evidence and expert opinion.

Time frame: 2016-2025.

Stakeholder constituencies (public and private sectors, health and non-health sectors): Researchers, professionals, public health functionaries, policy makers, communities and their leadership, civil society and donor agencies.

Translation and implementation context: Public and private health systems of India and their existing as well as future policies and programmes.

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from 256 institutions) and the Larger Reference Group (LRG) (84 members group) constituted with Central and State policy decision makers, politicians and bureaucrats from key ministries, MNCHN programme managers, eminent researchers and representatives from research funding organizations. The list of participants in the Nationwide Network is provided in Supplementary Table I (available at *http://www.ijmr.org.in/articles/2017/145/5/images/IndianJMedRes_2017_145_5_611_215547_sm6.pdf*). [The list of all participants in the exercise with respective institutional affiliation is available on *www.inclentrust.org*].

The NSG for the exercise, co-chaired by the Secretary, Department of Health Research (DHR) and Director General (DG)-ICMR and the Executive Director of The INCLEN Trust International, was formed with key officials from concerned Ministries, namely, Ministry of Health & Family Welfare (MoHFW) (National Health Mission, Child Health, Maternal Health and Nutrition Divisions, Directorate General of Health Services and DHR-ICMR), Ministry of Women and Child Development [Integrated Child Development Services (ICDS), Food and Nutrition Board] and Ministry of Science and Technology (Department of Biotechnology, Department of Science & Technology). There was a wide range of invited subject experts, Central and State programme managers, national and international donors and multilateral agencies, who were members. Two NSG meetings were organized, one at the initiation of the exercise to ratify the context and protocol (April 18, 2013) and second, at the conclusion for reviewing and endorsing the findings (February 4, 2016).

The Thematic RSCs contributed to research ideas in the first round of crowdsourcing, helped in refining and consolidating the ideas into research options, finalizing the scoring criteria, participated in second round of crowdsourcing for scoring the research options and presented the results to the NSG for ratification.

The Nationwide Network of experts participated in the first and second round of crowdsourcing for pooling of research ideas and scoring the research options, respectively.

The LRG assigned relative weights to the five scoring criteria, namely answerability, relevance, equity, innovation and out-of-the-box thinking and investment on research.

The exercise was centrally coordinated by the RPS Management Team at the Executive Office of The INCLEN Trust International, New Delhi.

The RPS Management Team established a national network of 1066 experts from institutions across India during 2012-2013. During the same period, it completed an extensive review of literature (research, academic and policy documents) on burden of diseases of MNCHN in India and presented the summary to the NSG at its first meeting. The NSG decided that topmost causes collectively accounting for at least 75 per cent of mortality and morbidity burden (Areas of Concern) for each of the RPS themes so identified shall guide pooling of research ideas and subsequent framing of research options for priority setting. Between September and December 2013, 3498 research ideas were pooled from the nationwide network using custom-designed online software (1st round of crowdsourcing). The participation rate was 42.3 per cent [of the 1178 experts contacted (1066-national members and 112-RSC members), 498 experts contributed research ideas]. Several of these research ideas were narrations comprising more than one research idea spanning across themes, areas of concern and domains. With the help of RSC members (January 2014-February 2015), these were split and refined into 4003 research ideas that were further consolidated into 373 research options (Maternal: 122, Newborn: 56, Child: 101 and Nutrition: 94) (*http://inclentrust.org/inclen/?page_id=8666*). Five criteria (answerability, relevance, equity, innovation and out-of-the-box thinking and investment on research) were identified and defined for scoring the research options (March-June 2015) (Box 2). This was done through a comprehensive review of criteria that had been used in previous exercises at national and global levels and iterative discussion with RSC members and national and international CHNRI experts (University of Edinburgh, Johns Hopkins Bloomberg School of Public Health and the WHO).

Scoring of the research options was done independently by 893 experts (of the 1536 experts approached; Participation rate: 58.1%) using a customized online (*SurveyMonkey.com*) platform (July-October, 2015) (2nd round of crowdsourcing). The scores obtained by the research options were adjusted with criteria weights as assigned by the LRG (November, 2015-January, 2016) as per standard CHNRI data analysis practices[10]. The Average Expert Agreement (AEA) was also calculated for each research option score. The detailed methodology and process adopted for this priority setting has been published

Box 2. Criteria used for scoring the research options

Answerability: Can the research be done through ethical, transparent, well-designed, 'do-able' studies with the existing local and national capacities and or by strengthening the existing capacities through regional or global collaboration?

Relevance: Is it likely that the research would address a high burden condition and critical gap in knowledge?

Innovation and out-of-box thinking to resolve complex and refractory challenges: Does the new research have the potential for transformative change in the health system/ health care?

Equity: Is it likely that the research product will address the differences in health and nutrition that are systematically associated with social, cultural and economic hierarchies, ethnicity, gender, environment and geographic disadvantages, thereby reducing inequities?

Investment on research: Is it likely that the potential impact and benefits of the new knowledge on health/ nutrition will outweigh the considerations of investments on research?

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elsewhere[11]. The research options were categorized into four domains; description, discovery, delivery and development.

In addition to national priorities, the States and Union Territories in the country were grouped into three subnational regions to obtain regional priorities [Empowered Action Group (EAG) and North-Eastern States, States in Western and Southern India and States in Northern India (including West Bengal)] (Fig. 1).

The number of scorers ranged between 60 and 96 scorers across each region and theme. Therefore, four priority lists were obtained for each theme: one national and three regional priority lists. The NSG reviewed and discussed the ranked list of priorities and made focused observations on the patterns of research that had evolved as priorities and the possible interlinks between the priorities identified. It also discussed other potential priority research options that might not have made it to the topmost priority list. This helped enrich the structuring of the national research agenda and identify the way forward.

Outcome of the research priority setting (RPS) exercise in the four themes

About 43 per cent of all the research options scored pertained to the delivery domain and required implementation research methodology (Fig. 2). It was observed that in each of the four themes, a large

Fig. 1. Geographical context of the ICMR-INCLEN National Research Priority Setting Exercise for Maternal, Newborn, and Child Health and Nutrition (2016-2025) (Map courtesy: *www.mapsofindia.com* modified with permission).

proportion (70%) of the top ten prioritized issues were dealing with delivery domain of research and implementation of programmes. Amongst the top ten priorities identified at national level, delivery domain research options accounted for 80 per cent in maternal health, 70 per cent in newborn health, 60 per cent in child health and 70 per cent in nutrition themes. Significant differences were also observed between national and regional research priorities for all the four themes. The AEA was very high for the top ten priorities of research in the four themes both nationally and regionally. There were research options in the top ten regional priorities under various themes that did not figure in the national priority list. The Table enlists the top ten priorities identified under each theme by the exercise at the national level. Top ten priorities and their scores along with the national and region-specific ranks are provided in Supplementary Table II (available at *http://www.ijmr.org.in/articles/2017/145/5/images/IndianJMedRes_2017_145_5_611_215547_sm7.pdf*). Key priority research options under each MNCHN theme are summarized below.

Maternal health

The network indicated the need for developing and evaluating screening checklists and management algorithms for severe acute maternal morbidities (SAMMs), near-miss events, high-risk pregnancies,

Table. Top ten priority research options in maternal, newborn, and child health and nutrition themes at national level

Theme	Rank	Research option
Maternal Health	1	Development and validation of algorithms for prevention, early detection and management of severe acute maternal morbidities and near-miss events in resource-constrained settings
	2	Strategies to improve quality of care during childbirth in the public health system, for example, medical practices, LSCS, active management of third stage of labour, EmOC, biophysical profiling for foetal assessment, application of epidural anaesthesia during delivery; beneficiary counselling and communication inside the labour room
	3	Early identification, referral and management of high-risk pregnancies (having maternofoetal morbidities including IUGR, stillbirths and preterms) at all levels of health care
	4	Introduction of a validated and cost-effective cancer screening programme of reproductive system for women in the community and health facilities
	5	Improving EmOC services [*e.g*., risk prediction, identification and communication; prompt referral; service availability (safe transportation, skilled personnel, capacity, logistic, blood storage); accountability; innovations]
	6	Assess blood transfusion needs, current availability and delivery mechanisms of blood for pregnant women based on PHC and CHC catchment areas in the context of prevailing burden of severe anaemia and post-partum haemorrhage
	7	Implementation research for effective delivery of evidence-based care protocols/algorithms for prevention and management of post-partum haemorrhage at different levels of care
	8	Improving maternal death audits, protocols and practices in the public health care system (body handling, support to family, communication, autopsy, death audit and causality ascertainment)
	9	Process and impact evaluation of public health programmes targeted for adolescents (ARSH, AFHS, RMNCH+A, RTI/STI screening services) in urban and rural areas
	10	Develop and validate a self-assessment check list for pregnant women to identify warning signs and need for care seeking
Newborn Health	1	Designing and evaluating curriculums for skill building and their retention for health personnel involved in newborn care in the community and at various levels of health care system (*e.g*., training in identification of warning signs, safe injection practices, administration of oxygen therapy, *etc*.)
	2	Engaging and empowering family members and community in the care of newborn (including family centred care): barriers, strategies to overcome, impact, cost-effectiveness
	3	Identifying appropriate and effective strategies (messages and channels of communication) to promote community awareness on newborn care practices and social mobilization for early healthcare seeking (including utilization of existing nutrition and health services) to prevent adverse outcomes
	4	Low cost, feasible, portable technological innovations in equipment to improve capacity (diagnosis, identification and management) and outreach for foetal & neonatal care (especially, LBW, preterm: CPAP, surfactant therapy, *etc*.,) at various levels of the health system and their impact evaluation
	5	Improving the implementation (service availability, quality, programme management and referral chain robustness) of neonate centric programmes and services (RMNCH+A, JSSK, NSSK, IMNCI & F-IMNCI, SNCUs, *etc*.)
	6	Implementation of an integrated and comprehensive maternal and newborn healthcare package for delivering continuum of care: barriers, strategies to overcome, need for governance modification, maternal and newborn outcomes
	7	Strategies to scale up home-based newborn care: Role assignment and rationalization for frontline workers, barrier identification and mitigation, cost-effectiveness, impact

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Theme	Rank	Research option
	8	Strategies for social, economic, skill and knowledge empowerment of women and its impact on newborn, child and women's health
	9	Establishing an innovative framework of monitoring and supervision with in-built mechanism of accountability to improve performance of frontline workers and health personnel involved in neonatal care (*e.g*., physical supervision; engaging PRIs and clients; use of ICT, telemedicine, maternal health)
	10	Development and validation of protocols for the management of pregnant women at risk of pre-term delivery, in the healthcare system [*e.g*., nutritional, pharmaceutical (steroids, betamimetics, progesterone, nitroglycerine patches, prophylactic antibiotics, *etc*.), surgical, exercise and lifestyle counselling]
Child Health	1	Develop locally relevant cost-effective strategies to expand the coverage of UIP by reaching segments of populations that are traditionally left out (address system 1 and community-Level 2 challenges) (*i*) VPD epidemiology, system capacity, cold chain, safety surveillance; (*ii*) Hesitancy, dropout, outreach strategies, KAP of care provider, community and clients
	2	Improving administrative data quality and strengthening data-driven child health programme monitoring, action and accountability at PHC and district levels (*e.g*., line listing of households with children with NDD, use of ICT, develop novel indicators)
	3	Development and validation of low-cost technologies for screening, referral and management of childhood pneumonia and ARI in the community and at various levels of health care (*e.g*., maternal health, point-of-care diagnostics & therapeutics, management protocols, *etc*.)
	4	Strategies to promote WASH practices in the community to improve child health and nutrition
	5	Development of cost-effective, feasible, validated point-of-care diagnostics for malaria in children for use at community and different levels of healthcare
	6	Development of evidence-based guidelines for rational use of antibiotics for childhood morbidities in India: choice of antibiotic; route and delivery systems (*e.g*., nebulizers); duration of therapy; monitoring criteria; adjunct therapies
	7	Development of an integrated child health programme for improving quality of life of children: challenges and barriers; strategies to overcome; feasibility across the country; effectiveness, cost-effectiveness
	8	Establishing an effective and sustainable vaccine preventable disease surveillance programme (especially, measles and rubella, pneumonia and diarrhoea) in India [*e.g*., defining syndromes (fever and rash) and programme thresholds, forging PPPs, building upon polio infrastructure, using technology (maternal health, GIS, *etc*.)]
	9	Identifying cost-effective strategies for supplementation of micronutrients and probiotics to prevent and control childhood diarrhoea, pneumonia and other infections
	10	To establish nationwide multicentric antimicrobial surveillance and antibiotic stewardship programme for infectious morbidities during childhood
Nutrition (Maternal and Child)	1	Identify and evaluate strategies to promote healthful lifestyle (physical activity and diet behaviour) in children through school and home-based interventions
	2	Determine characteristics of mother friendly work place policies and governance framework that enable optimal care and nutrition of pregnant and lactating women and their children: identify barriers and challenges to implement (*e.g*., financial security and compensation for loss of pay; crèches at workplaces; provision for breast milk expression and storage for working mothers)
	3	Process, impact and economic evaluation of NRCs for management of severely malnourished children (*e.g*., quality of care and client satisfaction; implementation gaps and challenges, reasons for underutilization and relapse; IEC to mothers during stay and at discharge; impact assessment, effectiveness of the RUTF used in NRCs and plausibility of indigenous preparation with the help of SHGs)

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Theme	Rank	Research option
	4	Identifying strategies for engaging the male partners, families and communities to improve the nutrition of women of reproductive age group and under-five children
	5	Process, impact, and economic evaluation of community-based management of childhood malnutrition (including SAM): role, effectiveness and accountability of various stakeholders (including frontline workers)
	6	Impact and economic evaluation of WASH practices in the community on the nutrition of women and children
	7	Cost-effective strategies to improve the quality, quantity and coverage of food supplements provided under the Mid-Day Meal Programme to improve the nutritional status of school-going children
	8	Determining optimal growth trajectory of LBW (preterm, SGA) babies: nutrient and calorie requirements; strategies to minimize, mitigate development of chronic diseases
	9	Development and popularisation of improved varieties of traditional food items rich in micronutrients (*e.g.*, iron rich millets): adoption of viable business models and modifying value and supply chains
	10	Strategies to overcome barriers and improve implementation of WASH practices in the community with particular focus on poor, socially disadvantaged groups

AFHS, Adolescent Friendly Health Services; ARI, Acute respiratory infections; ARSH, Adolescent reproductive and sexual health; CHC, Community Health Centre; CPAP, Continuous positive airway pressure; EmOC, Emergency obstetric care; F-IMNCI, Facility-based Integrated Management of Newborn and Childhood Illnesses; GIS, Geographic information system; ICT, Information and communication technology; IEC, Information, education, communication; IMNCI, Integrated Management of Newborn and Childhood Illnesses; IUGR, Intra uterine growth restriction; JSSK, *Janani Shishu Suraksha Karyakram*; KAP, Knowledge, attitude and practice; LBW, Low birth weight; LSCS, Lower segment cesarean section; NDD, Neuro-developmental disorders; NRC, Nutrition rehabilitation centres; NSSK, *Navjaat Shishu Suraksha Karyakram*; PHC, Primary Health Centre; PPP, Public private partnership; PRI, *Panchayati Raj* Institutions; RMNCH+A, Reproductive maternal newborn child and adolescent health; RTI, Reproductive tract infections; RUTF, Ready-to-use therapeutic food; SAM, Severe acute malnutrition; SGA, Small-for-gestational age; SHG, Self help group; SNCU, Special Newborn Care Units; STI, Sexually transmitted infections; UIP, Universal Immunization Programme; VPD, Vaccine preventable diseases; WASH, Water, sanitation and hygiene

post-partum haemorrhage, stillbirth, eclampsia and cancers. Development of point of care diagnostics and technological solutions for SAMMs, perinatal hypoxia and foetal distress were ranked as high priorities. Research on strategies to empower families and women for better self-care and timely care seeking, and skill enhancement (including role rationalization, task shifting and sharing) along with accountability of health providers at different levels were scored as important priorities. Process and impact evaluation of existing maternal health programmes to improve outcomes, developing implementation strategies to improve the quality of different aspects of maternal care in health system and expanding their coverage were considered important research areas. Development of pharmaceutical protocols for prevention and clinical management and novel technological solutions for identifying SAMMs, epidemiology of stillbirths and expanding coverage of reproductive tract infection (RTI)/sexually transmitted infection programmes and specific studies on symptomatic and asymptomatic RTI and its impact on stillbirth, low birth weight (LBW), intrauterine growth restriction (IUGR) and abortions were scored as important regional priorities.

Newborn health

Newborn health priorities included strategies to improve delivery and quality of care of newborn health-oriented programmes; skill and capacity enhancement of service providers including pre-service changes in the curriculum with in-built mechanisms of accountability; empowering mothers, families and communities to improve care seeking and quality of care in home environments; multicentric antimicrobial surveillance and antibiotic stewardship programme; development of point-of-care diagnostics/biomarkers for improving neonatal outcome, particularly for LBW neonates (preterm and IUGR) and neonatal sepsis; use of information and communication technology and utilization of m-Health to improve access to newborn care.

Child health

Six areas emerged prominently within child health: (*i*) issues related to coverage of Universal

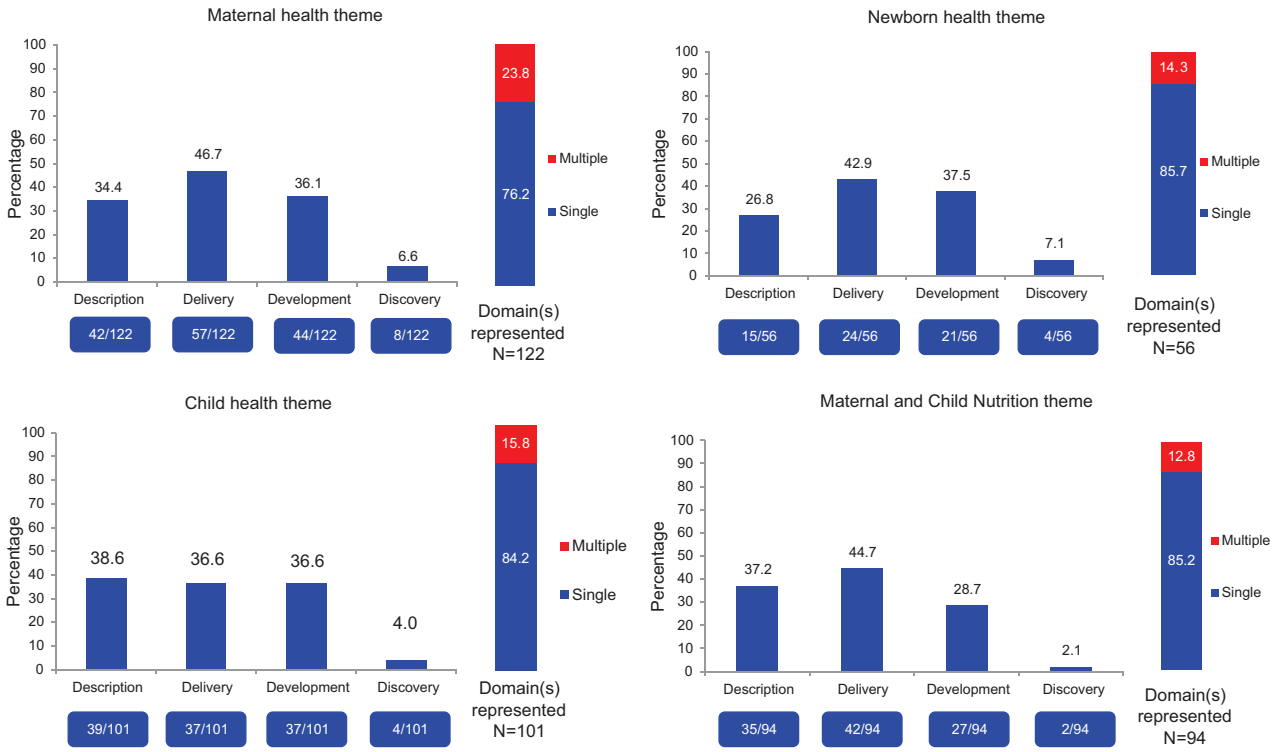

Fig. 2. Distribution of the research options in maternal, newborn, and child health and nutrition themes across the four domains of research.

Immunisation Programme (UIP) and surveillance for vaccine preventable diseases; (*ii*) point-of-care diagnostics; (*iii*) use of technology and development of biomarkers for the screening, referral and management of common childhood illnesses, namely, diarrhoea and acute respiratory infections (ARIs) along with improved control and management of malaria; (*iv*) rational use of antibiotics; (*v*) early childhood risk factors of adverse metabolic outcomes in later life, namely, obesity and metabolic syndrome; and (*vi*) water and sanitation hygiene (WASH). Operational and implementation research to effectively deliver different child health interventions in an integrated manner, including improving administrative data quality for decision-making, achieving Indian Public Health Standards at facilities, engaging community and its resources for better care seeking and care at home, strengthening curriculums for skill building and retention of personnel, was another area that scored high at both national and regional levels.

Maternal & child nutrition

Creation of mother friendly environments was an interesting and important priority to address issues of maternal and child nutrition. Research options that addressed the issues related to chronic diseases (*i.e.,* lifestyle behaviour modification interventions, point-of-care diagnostics and biomarkers for metabolic syndrome and nutrition of women around conception to prevent foetal programming and consequent risk for foetal origin of adult diseases) also scored high. Research options for enhancing skill of care providers and empowerment of families and communities including behavioural change communication were prioritized as was observed for other thematic areas. Research options around WASH (environmental and water hygiene) were scored high by experts across the country. Importantly, these research options were seen across all four themes. Research options to explore the performance and impact of various nutrition and food supplementation programmes (including community-based management of childhood malnutrition, midday meal, ICDS and food items provided under National Food Security Programme), improvement of administrative data quality for decision-making and the multisectoral governance of agriculture-nutrition-health nexus were prioritized at both national and regional levels. Anaemia (including issues related to absorption of nutrients), growth trajectory of LBW and breastfeeding were important cross-cutting areas for both mother and child perspective and were scored high.

The LRG had assigned the highest weight to the scoring criterion of 'relevance' and the lowest weight to 'investment in research'. The relative weights assigned to the five scoring criteria by different categories of members within the LRG did not vary significantly.

Discussion

The NSG strongly endorsed the research priorities identified by the exercise as appropriate for investment by different science and research departments of the Government of India and other national and international donor agencies and academic institutions over the next decade. It felt that the research agenda established with this exercise was in alignment with the national programme for achieving the recently enunciated health-related Sustainable Development Goals (SDGs) and will facilitate in accomplishing the unfinished agenda of the MDGs.

The exercise engaged experts who were well dispersed across the country. Thus, for the first time, regional MNCHN research priorities could be identified. In all the four thematic areas, there were differences between the top ten national and regional priorities. This observation made it imperative to take cognizance of the unique research needs of the regions. Although not part of the current project, the NSG suggested that a systematic effort must be made to determine factors that could explain differences in national and subnational (regional) priorities. The States falling under the three regions vary in terms of their health infrastructure, programme implementation and governance, development indicators and availability of baseline information on various health indicators. This may to some extent, explain the differences in the emerging research priorities. Better understanding of these factors will be important to design need-based research programmes and policies for different parts of the country. There are significant rural and urban differences for the health challenges and these have assumed greater significance in the light of rapid urbanization in certain parts of the country. The rural-urban divide will also have to be kept in mind when decisions on research investments are made.

In addition to the top priorities identified by the exercise, the NSG highlighted some more areas of research in MNCHN themes that deserve investment. These included role of environmental exposures in the occurrence of neurodevelopmental disorders such as autism; early childhood care and stimulation for improving cognitive outcomes; better description of childhood cancers and their risk factors; unsafe abortions; innovations to solve the 'nutrition enigma'; factors interfering with iron absorption in both women and children; impact of fluoride on health and nutrition of women and children; micronutrient deficiencies and occurrence of congenital birth defects (*e.g*., neural tube defects with folic acid deficiency); research into processes and strategies to make multisectoral governance for human nutrition workable and effective and technology innovation for developing better tools of nutrition assessment.

As part of Infant and Young Child Feeding and Complementary Feeding research agenda, NSG has also suggested that it is important to innovate strategies to promote breastfeeding; innovation is also needed in the development of low cost nutritious and healthy processed foods that require minimal cooking, are prepared from indigenous raw material and are appropriately fortified. This is important in the context of giving relief to severely time-constrained mothers who have now entered the workforce in a considerable way. Legislations affecting women and child health and nutrition are an important aspect to consider when research programmes and investment decisions are made. NSG suggested that researchers and funding agencies should work with Food Safety and Standards Authority of India in MoHFW to better understand regulatory issues related to food processing and related nutritional impacts.

Adolescents constitute almost 25 per cent of the Indian population. They suffer from several health problems that have been hitherto neglected. The foundation of several chronic diseases in the form of exposure to risk factors is laid during the adolescent years. NSG advised that adolescent-related research options were culled from the four themes and put forward separately with a caveat that scorers did not have an opportunity to see all the options in this section together. These have been put together in Supplementary Table III (available at *http://www.ijmr.org.in/articles/2017/145/5/images/IndianJMedRes_2017_145_5_611_215547_sm8.pdf*). However, as adolescent health was not stated as a theme on its own for prioritization, the research options that were chosen from within the other sections may not reflect the true priorities in adolescent health. An independent exercise may be undertaken where adolescent health is given a focus (One example where a gap can easily be seen is interventions to target adolescent boys or interventions looking at accidental

injury or drowning which carry a huge burden in this age group).

The NSG acknowledged implementation research as an important area for consideration. This necessitates bridging the 'disconnect' between the research community, the policy and programme makers, implementers and the communities to achieve the desirable impact. Implementation research involves behavioural changes of health providers, and this cannot be overlooked. Some of the prioritized implementation research options can also help the national and State administrators to either commission research studies or decide to reset the way, in which the health system is working. This will also provide an opportunity for re-engineering health systems and programmes to improve their efficiencies: by dropping redundant programmes and/or making way for newer, refined and 'need of the hour' programmes. As a cross-cutting research priority, the NSG strongly pitched the imperatives of improving the quality of administrative data for better use in decision-making at ground level.

The NSG members observed that several of the priority research issues were cross-cutting and common across the four themes; these should be brought together as common research agenda for MNCHN. This will make the research investment efficient and effective by addressing more than one theme at a time and also align the research projects with the national goal to achieve universal healthcare in India. As a follow up on this suggestion, the investigator team has prepared a separate list of cross-cutting research options [Supplementary Table IV (available at *http://www.ijmr.org.in/articles/2017/145/5/images/IndianJMedRes_2017_145_5_611_215547_sm9.pdf*)]. Similarly, as technology has cross-cutting usage, another list of research options related to research on the use of technology for health has been prepared for consideration by agencies with mandate to exclusively fund such research [Supplementary Table V (available at *http://www.ijmr.org.in/articles/2017/145/5/images/IndianJMedRes_2017_145_5_611_215547_sm10.pdf*)].

The NSG strongly advised that the DHR and other science ministries along with MoHFW should make efforts to pool resources for addressing priority research issues and also encourage national and international agencies to come together to invest strategically for greater and faster impact. The NSG has suggested that a number of research issues have the ability to be 'game changers' for the health systems, and for the health and nutrition of mothers and children, in general. These can be systematically identified and taken up in a mission mode by science ministries and donor agencies as per their own prioritization and investment policies. Recognizing the challenges of programme delivery in the context of weak infrastructure, national policymakers and programme planners have already identified north-eastern States and EAG States for the focus of several developmental schemes including health and nutrition (*http://nhm.gov.in/nhm/nrhm.html*). To further accelerate the developmental process, region-specific research agenda should become natural corollary. Health is a State subject in India and implementation of research issues can be integrated with the programme monitoring and evaluation frameworks existing therein. The research agenda could be accomplished in an accelerated manner and effectively with multistakeholder and multi-agency engagement through a broader convergent innovation coalition that will add to existing sectoral and cross-sectoral capacity for science, social sciences, economics, technology, innovation, strategy and policy to achieve better health and nutrition for mothers and their children in India.

Conclusion

It was concluded that the logical way forward for this exercise would be to take up these research priorities with different governmental and non-governmental agencies for investment. Various government and non-governmental funding agencies were requested to now re-align their investment with these priorities to achieve better health and nutrition for women and children of India effectively and efficiently. Further, bridging the gap between researchers and programme implementers at the grass root level would be essential along with decentralization of strategies to have State and possibly, district centric solutions for the betterment of health and nutrition scenario in India. In view of the predominance of delivery and implementation research identified as priority in all thematic areas, it was suggested to explore the possibility of supporting such research projects from the programme funds.

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Reprint requests: Dr Narendra K. Arora, Executive Office, The INCLEN Trust International, F-1/5 (2nd Floor), Okhla Industrial Area (Phase I), New Delhi 110 020, India
e-mail: nkarora@inclentrust.org