

Supplementary Table II. Top ten priority research options in maternal, newborn, child health and nutrition themes

National weighted priority ranks	Research options	Regional priority ranks		
		EAG & North Eastern States	Southern & Western States	Northern States (including West Bengal)
Priority research options in 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	1	4	
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	10	1	4

	room			
3	Early identification, referral and management of high-risk pregnancies (having maternofetal morbidities including IUGR, stillbirths and pre-terms) at all levels of health care	4	7	
4	Introduction of a validated and cost-effective cancer screening programme of reproductive system for women in the community and health facilities	2		8
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	6	
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		5	

	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	7
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)			2
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 checklist for pregnant women to identify warning signs and need for care seeking	3		
(i)	Epidemiology, risk and prognostic factors (biological, genetic, maternal, familial, social-cultural, economic, gender, demography, health			10

	system related, environmental) of stillbirth			
(ii)	Implement protocols for early detection and management of foetal distress and hypoxia in the public health system		9	
(iii)	Foetal distress and hypoxia: development of appropriate technologies (namely, low-cost pulse oximetry, Doppler, foetal monitors) for early detection and management in the public and clinical health services		2	
(iv)	Time motion studies of primary care personnel (ASHA, AWW, ANMs and MO working in PHCs and CHCs) to rationalize task assignment and personnel requirements, improve performance and enhance accountability			1
(v)	Developing strategies for engaging the male partners, families and communities in the care of women of reproductive age group			6

<i>(vi)</i>	Development and evaluation of novel technological solutions (point-of-care diagnostics, mobile based detection systems) that can be used by frontline workers and primary care physicians for identifying SAMMs in the community and PHCs		3	9
<i>(vii)</i>	Process and impact evaluation of maternal and reproductive health services: Outreach, access and utilization gaps and patterns; determinants and challenges; resource issues (programme management, personnel, logistic, supply chain, social mobilization and community participation)			3
<i>(viii)</i>	Identification/development of an evidence based pharmaceutical protocol for prevention & clinical management of pregnancy induced hypertension and hypertensive crisis at various levels of the healthcare system		10	
<i>(ix)</i>	Use of modern teaching and learning methods including ICT and distance learning for skill building and retention in health personnel involved in maternal and reproductive health at various	8		

	levels of care			
(x)	Strategies for expanding coverage of RTI/STI programmes including community-based treatment of RTI/STI amongst women of reproductive age group (<i>e.g.</i> , use of point-of-care diagnostics, maternal health & strategies for management, compliance, monitoring and followup)	9		
(xi)	Design a feasible and validated package (content and strategy) for community-based pre-marital counselling for improving reproductive and sexual health of women; impact evaluation	5		
(xii)	Validate the effectiveness of 5×5 matrix of RMNCH + A programme in real life situations and evolve into a 5×5×5 grid that engages five stakeholders (mother-child, family, community, frontline workers, health system personnel) for enhanced impact			5
(xiii)	Relationship of symptomatic and asymptomatic	7		

	RTI with stillbirth, preterm birth and low birth weight rates and neonatal morbidities			
Priority research options in 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 (<i>e.g.</i> , training in identification of warning signs, safe injection practices, administration of oxygen therapy, <i>etc.</i>)	1	1	
2	Engaging and empowering family members and community in the care of newborn (including family centred care): Barriers, strategies to overcome, impact, cost-effectiveness	5	9	8
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	2	10	

4	Low cost, feasible, portable technological innovations in equipment to improve capacity (diagnosis, identification and management) and outreach for foetal & neonatal care (especially, LBW, pre-term: CPAP, surfactant therapy, <i>etc.</i>) at various levels of the health system and their impact evaluation	7		1
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, <i>etc.</i>)	4		3
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		3	
7	Strategies to scale up home-based newborn care: Role assignment and rationalization for frontline workers, barrier identification and mitigation,			2

	cost-effectiveness, impact			
8	Strategies for social, economic, skill and knowledge empowerment of women and its impact on newborn, child and women's health		6	
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 (<i>e.g.</i> , physical supervision; engaging PRIs and clients; use of ICT, telemedicine, maternal health)	3		10
10	Development and validation of protocols for the management of pregnant women at risk of pre-term delivery, in the healthcare system [<i>e.g.</i> , nutritional, pharmaceutical (steroids, betamimetics, progesterone, nitroglycerine patches, prophylactic antibiotics, <i>etc.</i>), surgical, exercise and lifestyle counselling]			9
(i)	Process, impact and economic evaluation of neonate centric programmes and services	10		5

	(RMNCH+A, JSSK, NSSK, IMNCI & F-IMNCI, SNCUs, <i>etc.</i>)			
(ii)	To establish nation-wide multicentric antimicrobial surveillance and antibiotic stewardship programme for infectious morbidities during neonatal period; encouraging rational use of antibiotics		2	
(iii)	Developing context-specific triage protocols for pregnant women (coming for their antenatal and emergency room visits) and newborns to improve quality of care and neonatal outcomes	9		
(iv)	Developing and validating point-of-care diagnostics, biomarkers (neonatal, maternal, amniotic fluid; core-to-periphery temperature gradient) and a scoring system based on these for identification and prognostication of neonatal sepsis in the community and at primary care level			6
(v)	Use of ICT and maternal health to improve access to neonatal health services and associated entitlements (increase service quality, outreach and awareness; improve monitoring and screening			4

	for early identification of morbidities; strengthen client referral, tracking and treatment compliance)			
(vi)	Development, implementation and assessment of quality benchmarks for neonatal care at different levels of healthcare			7
(vii)	Designing and evaluating undergraduate medical curricula for skill building in newborn care amongst students		5	
(viii)	Epidemiology, risk and prognostic factors (biological, genetic, maternal, familial, social-cultural, economic, gender, demography, health system related) in low birth weight babies		4	
(ix)	Development of evidence-based, feasible, affordable, care protocols for prophylactic/standard/rescue management of pre-term neonates at different levels of the health system (e.g., rescue surfactant therapy)	6		
(x)	Immersion of validated protocols of aseptic newborn care practices at different levels of health		7	

	care; fixing accountability			
(xi)	Identifying optimal feeding regimens for preterm and LBW babies and their short-term (growth trajectory) and long-term (chronic disease, obesity) outcomes	8	1	
(xii)	Assess impact of common practices during delivery and postnatally (<i>e.g.</i> , delayed cord clamping, milking of cord, resuscitation, use of oxygen, management of hyperbilirubinemia, <i>etc.</i>) on neonatal outcomes		8	
Priority research options in 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		1	8

2	Improving administrative data quality and strengthening data-driven child health programme monitoring, action and accountability at PHC and district levels (<i>e.g.</i> , line listing of households with children with NDD, use of ICT, develop novel indicators)	2	3	
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 (<i>e.g.</i> , maternal health, point-of-care diagnostics & therapeutics, management protocols, <i>etc.</i>)	7		1
4	Strategies to promote WASH practices in the community to improve child health and nutrition		2	
5	Development of cost-effective, feasible, validated point-of-care diagnostics for malaria in children for use at community and different levels of healthcare	4		3
6	Development of evidence-based guidelines for rational use of antibiotics for childhood morbidities in India: choice of antibiotic; route	3		

	and delivery systems (<i>e.g.</i> , 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		6	7
8	Establishing an effective and sustainable vaccine preventable disease surveillance programme (especially, measles and rubella, pneumonia and diarrhoea) in India [<i>e.g.</i> , defining syndromes (fever and rash) and programme thresholds, forging PPPs, building upon polio infrastructure, using technology (maternal health, GIS, <i>etc.</i>)]		8	9
9	Identifying cost-effective strategies for supplementation of micronutrients and probiotics to prevent and control childhood diarrhoea, pneumonia and other infections		10	
10	To establish nationwide multicentric antimicrobial surveillance and antibiotic			

	stewardship programme for infectious morbidities during childhood			
(i)	Identifying novel low-cost environment-friendly strategies for control of vectors		7	
(ii)	Strategies to engage the community and its resources (organizations and personnel) in improving the quality and outcome of community-based management of childhood morbidities	10	9	
(iii)	Identifying barriers and strategies to overcome and achieve IPHS benchmarks at primary and secondary level health facilities	9		
(iv)	Identifying effective communication strategies (messages and channels) to improve awareness on child care and feeding practices during illness			6
(v)	Impact, process and economic evaluation of national vector borne disease control programme in the context of improving child health	8		
(vi)	Impact evaluation of UIP programme with particular emphasis of recently introduced vaccines (<i>e.g.</i> , pentavalent, measles SIAs, <i>etc.</i>)		4	

(vii)	Impact of artemisinin combination therapy on malaria disease epidemiology and resistance patterns in India			5
(viii)	Improving diarrhoea control strategies in the public health system (ORS, Zinc, WASH, rational antibiotic and drug use)		5	10
(ix)	Developing novel, cost-effective therapeutic regimens for treatment of resistant childhood malaria			4
(x)	Undertake systematic child health policy analysis for identifying strengths and gaps and developing policy guidance to meet sustainable development goals	1		
(xi)	Integrate, revise and evaluate curriculums for comprehensive skill building and their retention for health personnel involved in child health and nutrition services at all levels of care	6		
(xii)	Development of portable water purifiers and recyclers for generating potable water at household levels	5		

(xiii)	Identifying interventions to prevent/minimize development of adverse cardiometabolic and neurodevelopmental outcomes in LBW (pre-term & SGA) babies			2
Priority research options in Maternal Nutrition				
1	Determine characteristics of mother friendly workplace policies and governance framework that enable optimal care and nutrition of pregnant and lactating women and their children: identify barriers and challenges to implement (<i>e.g.</i> , financial security and compensation for loss of pay; crèches at workplaces; provision for breast milk expression and storage for working mothers)		1	1
2	Identifying strategies for engaging the male partners, families and communities to improve the nutrition of women of reproductive age group and under-five children	6	2	3
3	Development and popularisation of improved varieties of traditional food items rich in micronutrients (<i>e.g.</i> , iron rich millets): Adoption of viable business models and modifying value		4	8

	and supply chains			
4	Strategies to overcome barriers and improve implementation of WASH practices in the community with particular focus on poor, socially disadvantaged groups	4		
5	Identifying challenges of intersectoral partnerships between agriculture, nutrition and health sectors	8		6
6	Identify programme innovations to improve delivery and compliance to therapeutic and prophylactic supplementation of Iron and folic acid in women of reproductive age group and adolescents (e.g. IEC; co-administration of parenteral iron with antenatal tetanus toxoid; simultaneous deworming, absorption enhancers like vitamin C rich foods, directly observed administration; developing a mobile app, incentivization; co-packaging of IFA tablets with sanitary napkins)	10		9
7	Development and evaluation of a governance	5		2

	<p>model for improving mother and child nutrition [e.g., setting up a multi-sectoral (including community representation) District Nutrition Board that oversees implementation and monitors the district nutrition programmes particularly those focusing on women and children of poor and socially backward communities; making the block nutrition development plan operational as suggested by the nutrition coalition, <i>etc.</i>]</p>			
8	<p>Developing strategies to overcome the barriers for mothers to exclusively breast feed their infants for six months within the existing socio-cultural and economic environments</p>	1	6	
9	<p>Design context and culture specific nutritional interventions for preconception and post-conception women to promote optimal foetal growth, reduce the risk of LBW (pre-term and SGA) and to minimize the risk of foetal programming for obesity and other chronic diseases in later life</p>		3	
10	<p>Process, impact and efficiency of current</p>			4

	programmes to ensure food and nutrition security for poor and socially backward communities			
(i)	Modifying existing IFA supplementation programme to include vitamin B12 and evaluating effectiveness, affordability and impact on prevalence of anaemia in different age groups	2		
(ii)	Cost-effective strategies to make the ICDS food supplements (freshly cooked food and take home ration) more nutritious, attractive and locally acceptable		5	
(iii)	Designing and evaluating curricula for skill building and their retention for health personnel to promote nutrition of women of reproductive age group, adolescents and EBF-IYCF for infants and children in community and health facilities			5
(iv)	Identifying barriers and challenges (familial, social-cultural, economic, gender, demography, health system related, environment) in translating the current IEC and BCC messages (related to both macro and micro nutrients) to improved dietary intake in women of reproductive age group		8	

	and children, and developing strategies to overcome these			
(v)	Process, impact and economic evaluation of the programmatic services provided through the public health care system for prevention and control of nutritional anaemia in different age groups: National Nutritional Anaemia Prophylaxis Programme and nutrition supplementation services	3		
(vi)	Process, impact and economic evaluation of Iron and folic acid supplementation services in pregnant and reproductive age women: Barriers to effective implementation and strategies to improve coverage			10
(vii)	Development and evaluation of novel and innovative point-of-care diagnostics for use by frontline workers and primary care physicians for identifying nutritional disorders			7

(viii)	Improving administrative data quality and strengthening data-driven monitoring, action and accountability at PHC and district levels for programmes related to nutrition of women of reproductive age (<i>e.g.</i> , building community-based registry of maternal health and nutritional disorders, use of ICT, develop novel indicators)		9	
(ix)	Developing evidence-based strategies to accelerate the impact of current policies and programmes aimed at empowering women's status in the society	7		
(x)	Characterization of refractory anaemia in women of reproductive age group and developing novel, affordable, therapeutic strategies		7	
(xi)	Epidemiology, aetiological profile, risk and prognostic factors (biological, genetic, maternal, familial, social-cultural, economic, gender, demography, health system related, environment) of anaemia in women of reproductive age & their health outcomes		10	

(xii)	Dynamics of iron absorption in individuals residing in diverse environmental and sanitary conditions, belonging to different socioeconomic classes and nutritional status	9		
Priority research options in Child Nutrition				
1	Identify and evaluate strategies to promote healthful lifestyle (physical activity and diet behaviour) in children through school and home-based interventions	7	2	1
2	Determine characteristics of mother friendly workplace 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)		1	4
3	Process, impact and economic evaluation of NRCs for the management of severely malnourished children (e.g., quality of care and client satisfaction; implementation gaps and challenges,	2	9	6

	reasons for under-utilization 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)			
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		4	7
5	Process, impact and economic evaluation of community-based management of childhood malnutrition (including SAM): Role, effectiveness and accountability of various stakeholders (including front-line workers)	6		3
6	Impact and economic evaluation of WASH practices in the community on the nutrition of women and children		8	2
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		10	

	children in India			
8	Determining optimal growth trajectory of LBW (pre-term, SGA) babies: Nutrient and calorie requirements; strategies to minimize, mitigate development of chronic diseases	9	3	
9	Development and popularization of improved varieties of traditional food items rich in micronutrients (<i>e.g.</i> , iron rich millets): adoption of viable business models and modifying value and supply chains		7	
10	Strategies to overcome barriers and improve implementation of WASH practices in the community with particular focus on poor, socially disadvantaged groups	8		
(i)	Development of novel and innovative recipes of nutritious complementary and therapeutic feeds (RUTF) using locally available ingredients		6	

(ii)	Development and evaluation of a governance model for improving mother and child nutrition [e.g., setting up a multisectoral (including community representation) District Nutrition Board that oversees implementation and monitors the district nutrition programmes particularly those focusing on women and children of poor and socially backward communities; making the Block Nutrition Development Plan operational as suggested by the Nutrition Coalition, <i>etc.</i>]	10		5
(iii)	Developing strategies to overcome the barriers for mothers to exclusively breast feed their infants for six months within the existing sociocultural and economic environments	3		
(iv)	Design context and culture-specific nutritional interventions for pre-conception and post-conception women to promote optimal foetal growth, reduce the risk of LBW (preterm and SGA) and to minimize the risk of foetal programming for obesity and other chronic diseases in later life		5	

(v)	Process, impact and efficiency of current programmes to ensure food and nutrition security for poor and socially backward communities			9
(vi)	Modifying existing IFA supplementation programme to include vitamin B12 and evaluating effectiveness, affordability and impact on prevalence of anaemia in different age groups	4		
(vii)	Designing and evaluating curricula for skill building and their retention for health personnel to promote nutrition of women of reproductive age group, adolescents and EBF-IYCF for infants and children in community and health facilities			10
(viii)	Process, impact and economic evaluation of the programmatic services provided through the public healthcare system for prevention and control of nutritional anaemia in different age groups: National Nutritional Anemia Prophylaxis Programme and nutrition supplementation services	5		
(ix)	Feasibility of combating childhood malnutrition in	1		

	India in a nationwide programmatic framework			
(x)	Developing point-of-care diagnostics for childhood obesity and chronic diseases (<i>e.g.</i> , diabetes mellitus, hypertension, <i>etc.</i>) for use by frontline workers and primary care physicians			8

AFHS, Adolescent Friendly Health Services; ANM, Auxiliary nurse midwife; ARI, Acute respiratory infection; ARSH, Adolescent reproductive and sexual health; ASHA, Accredited Social Health Activist; AWW, *Anganwadi* worker; BCC, Behavior change communication; CHCs, Community Health Centres; CPAP, Continuous positive airway pressure, EAG, Empowered Action Group; EBF-IYCF, Exclusive breastfeeding-infant and young child feeding; EmOC, Emergency obstetric care; GIS, Geographic information system; ICDS, Integrated Child Development Services; ICT, Information and Communication technology; IEC, Information education communication; IFA, Iron and folic acid, IPHS, Indian Public Health Standards; IUGR, Intrauterine growth restriction; KAP, Knowledge, attitude and practice; LBW, Low birth weight; LSCS, Lower segment cesarean section; MO, Medical officer; NDD, Neurodevelopmental disorder; NRCs, Nutrition Rehabilitation Centers; ORS, Oral rehydration salts; PHCs, Primary health centres; PPPs, Public private partnerships; PRIs, *Panchayati Raj* institutions; RMNCH + A, Reproductive maternal neonatal child health + adolescent; RTI, Reproductive tract infection; RUTF, Ready-to-use therapeutic food; SAM, Severe acute malnutrition; SAMMs, Severe acute maternal morbidity; SGA, Small for gestational age; SHGs, Self-help groups; SIAs, Supplementary immunization activities; STI, Sexually transmitted infection; UIP, Universal Immunization Programme; VPD, Vaccine preventable disease; WASH, Water and sanitation hygiene.