

Health systems interventions for meeting SDG targets on neonatal mortality in India

This document is a supplement to the policy brief on the issue.

Jyoti Tyagi, Misimi Kakoti, Nachiket Gudi, Sandeep Moola, Devaki Nambiar, Soumyadeep Bhaumik

List of abbreviations

ANC- Ante-Natal Care
BFHI- Baby Friendly Hospital Initiative
CBSVs- Community Based Surveillance Volunteers
EmOC- Emergency Obstetric Care
ENC- Essential Newborn Care
EPOC- Effective Practice and Organisation of Care
HBB- Helping Babies Breathe
HCPs- HealthCare Practitioners
HIC- Higher Income Countries
LHW- Lay Health Workers
LMICs- Lower Middle Income Countries
mHealth -Mobile Health
MMR- Maternal Mortality Rate
NBSU- New-born Stabilisation Unit
NICU- New-born Intensive Care Unit
NMR- Neonatal Mortality Rate
PICOS– Population, Intervention, Comparator, Outcome, Study design
PNC- Post Natal Care
PoCUS- Point-of-Care Ultrasound
PRISMA- Preferred Reporting Items for Systematic Reviews and Meta-analyses
RCT- Randomised Controlled Trial
RES- Rapid Evidence Synthesis
SDG- Sustainable Development Goals
SNCU- Special New-born Care Unit
SR- Systematic Review
TCC- Targeted Client Communication
VAP- Ventilator-Associated Pneumonia

Contents

List of abbreviations.....	2
1. Introduction.....	6
2. Methods.....	7
Protocol	7
Eligibility Criteria.....	7
Exclusion criteria:.....	8
Information sources	8
Study selection, data collection, and reporting.....	8
Selection of studies	8
Data extraction and management	8
Assessment of methodological quality of included studies	8
Data Synthesis.....	8
3.Results.....	9
Description of studies	9
Search results and study selection	9
Characteristics of the included studies	9
<i>Table 2: Characteristics of included Systematic reviews.....</i>	<i>11</i>
<i>Table 3: Summary of evidence for health system interventions.....</i>	<i>28</i>
Summary of findings from the included systematic reviews on health systems interventions.....	33
Delivery arrangements	33
Outreach services	33
The use of information and communication technology	34
Implementation strategies.....	40
Confidence in results of included SRs	46
4. References	46
5. Appendices	48
Appendix 1: Search strategies	48
Appendix 3 – PRISMA flow charts.....	50

Contributions of authors

Study selection, data extraction, critical appraisal, formal analyses, writing (original draft preparation) – Jyoti Tyagi

Study selection, data extraction, draft review – Misimi Kakoti

Data extraction, critical appraisal, draft review – Nachiket Gudi

Draft review and editing – Devaki Nambiar

Critical appraisal, draft review and editing – Sandeep Moola

Conceptualisation, methodology, searching, draft review – Soumyadeep Bhaumik

Competing interests

The authors do not have any relevant competing interests.

Acknowledgements

This gratis rapid evidence synthesis was made possible due to the support from World Health Organization, Alliance for Health Policy and Systems Research. The funder did not have a role in drafting, revising or approving the content of the policy brief.

The authors would also like to acknowledge and thank the National Health Systems Resource Centre (NHSRC) for their input during the protocol stage.

Email for correspondence

res@georgeinstitute.org.in

Suggested citation

Tyagi J, Kakoti M, Gudi N, Moola S, Nambiar D, Bhaumik S. Health systems interventions for meeting SDG targets on neonatal mortality in India. The George Institute for Global Health, India, December 2020.

Executive summary

The Sustainable Development Goals (SDGs) set a target of 12 deaths per 1000 livebirths for Neonatal Mortality Rate (NMR) by 2030. India has made substantial progress in the last few decades in improving child health. While overall child mortality has decreased, the proportion of deaths in neonates as a component of child deaths has increased. It has been predicted that if current trends are maintained, India will not be able to achieve the Sustainable Development Goals (SDG) related target of Neonatal Mortality Rate (NMR) of 12 deaths per 1000 live births by 2030. Moreover, there is a substantial variation between different states with some states surpassing the target while some states continue to lag substantially. We received a request from the National Health Systems Resource Centre (NHSRC) to inform strategies for decreasing neonatal mortality such that India can achieve the SDG nationally as well as sub-nationally (in states and Union Territories-UTs). Thus, we sought to understand the effectiveness of health system interventions to reduce neonatal mortality (with a focus on improving quality of care). Based on pre-specified inclusion criteria we identified 22 systematic reviews (SRs) and two overviews of SRs that were deemed eligible for inclusion in the report. The majority of the health system interventions were categorised under delivery arrangements domain and implementation strategies. However, no evidence was found on governance and financial arrangements. Evidence suggest community-based educational interventions, outreach services like antenatal care visits, mHealth interventions, community health worker programs to deliver antepartum and postpartum care through home visits together with provision of maternity waiting homes, inter-professional education, training leaders of obstetric in conducting maternal death reviews, multifaceted strategies aimed at continuous quality improvement and a combination of outreach services and community mobilisation improved neonatal and perinatal outcomes.

1. Introduction

Globally 2.6 million children die in the first month of life and approximately 7000 newborn deaths occur every day, with about one million dying on the first day and close to one million dying within the next six days of life. Most of these deaths occur in low- and middle-income countries (LMICs).(1) The United Nations' Sustainable Development Goals (SDG) include reducing the global Neonatal Mortality Rate (NMR) to fewer than 12 per 100,000 live births and ending preventable deaths of newborns and children under five years of age. The majority of maternal and perinatal deaths are clustered around the time of birth, with the highest number of deaths occurring within the first 24 hours after childbirth.(2) These deaths are associated with lack of quality care at birth or skilled care and treatment immediately after birth and in the first days of life. Half of all stillbirths occur in the intrapartum period due to its close relation to poor maternal outcome.(3)

India has made substantial progress in the last few decades in improving child health. While overall child mortality has decreased, the proportion of deaths in neonates as a component of child deaths has increased. It has been predicted that if current trends are maintained, India will not be able to achieve the Sustainable Development Goals related target of Neonatal Mortality Rate. To reach the target, more effective way of delivering quality preventive and curative care need to be identified and monitored. Moreover, there is a substantial variation between different states with some states surpassing the target while some states continue to lag substantially.

The Rapid Evidence Synthesis (RES) unit of the George Institute for Global Health received a request from the National Health Systems Resource Centre (NHSRC) to inform strategies for decreasing neonatal mortality such that India can achieve SDGs nationally as well as sub-nationally (in states and Union Territories-UTs). Upon discussion with the requester, the need for understanding the effect of different interventions on NMR and issues of quality of care were considered to be important. As such, we aimed to understand the effectiveness of health system interventions to reduce neonatal mortality (with a focus on improving quality of care).

2. Methods

Protocol

The review protocol was not formally registered owing to the rapid nature. However, an a-priori protocol was developed before running formal search and one author (SB) acted as a custodian of the protocol. Difference between protocol and reviews is noted in a subsequent section below.

Eligibility Criteria

We included studies, which met the following criteria:

Population

Reviews that have included studies with neonates as participants irrespective of whether they are suffering from any health condition or not were included. Studies which included pregnant women and reported neonatal data were included too.

Intervention

We included reviews that have included any health system intervention which targeted neonatal outcomes and were delivered during labour and childbirth, on immediate new-born care, care of small and sick new-borns, and/or on care of healthy new-borns. We used the Cochrane Effective Practice and Organisation of Care (EPOC) review group's definition of health system interventions involving changes in healthcare delivery, financing, governance, and/or implementation. (4) This is in alignment with discussions with our requester wherein the focus of decision making was to prioritise interventions during neonatal period and childbirth interventions, and focus on health system interventions.

Outcome

Primary outcomes:

- Neonatal mortality rate
- Early neonatal mortality rate
- Late neonatal mortality rate
- Peri-natal mortality rate
- Death in neonates due to any specific cause

Study Designs

Overview of systematic reviews (SR) and systematic reviews (SRs) irrespective of the design of the individual studies were considered.

Settings

We included reviews irrespective of study setting.

Exclusion criteria: We did not include the health systems interventions around preconception and antenatal phases as they have lowest impact on neonatal mortality (India Newborn Action Plan, 2014). We also excluded data on still-birth outcomes.

Information sources

Comprehensive search strategies (**Appendix 1**) for identifying SRs and/or overview of SRs were developed, and searches were carried out in Medline and Embase. The search was restricted to those which were published on or after 1st January 2017 in order to provide updated evidence.

Study selection, data collection, and reporting

Selection of studies

The titles and abstracts of studies for potential inclusion were screened independently by two reviewers (JT, MK). For the studies deemed relevant, full texts were retrieved and screened (JT, MK) for eligibility as per the eligibility criteria.

Data extraction and management

Data from included reviews were extracted using a pre-designed template.

Assessment of methodological quality of included studies

No quality appraisal was conducted for overviews of SRs. However, for SRs, quality assessment was done using AMSTAR-2 by three reviewers (JT, SM, NG)(5). Discrepancy, if any, was resolved by consensus. Quality of evidence on different outcomes were reported using the GRADE methodology (as reported in the reviews).

Data Synthesis

Effect estimates of interventions were extracted and tabulated from selected reviews. A narrative synthesis summary was presented that addressed the review question documenting relevant data and findings. Results only from the relevant studies included in systematic reviews are reported.

Difference between protocol and review

There were a few protocol deviations during the conduct of the overview. We had initially planned to update reviews conducted before 2017 as well as conduct de novo reviews for a minimal list of interventions (**Appendix-2**) through a new methodological approach called SERIES which we were piloting. However, owing to paucity of time, amount of evidence retrieved, and critically low quality SRs found we had to abandon the approach. Learnings from the current study will be used to refine the SERIES approach.

3. Results

This section provides a summary of the effectiveness of different interventions and strategies to improve neonatal care related outcomes.

Description of studies

Search results and study selection

Searches of the mentioned electronic databases were conducted in November 2020, which identified 3360 citations. After removal of 24 duplicates, we screened 3336 records based on titles and/or abstracts. We retrieved full texts of 82 SRs and overviews of SRs which were deemed to be potentially eligible for further examination. On full text screening, 22 SRs and two overviews of SRs were included in this report. **Appendix 3** depicts the study selection process in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram. The list of excluded studies (n=58/82) with reasons for exclusion at the full text level is presented in **Appendix 4**.

Characteristics of the included studies

Overall 24 reviews (1, 6-28) were included in the RES of which twenty two (1, 6-9, 11-25, 27, 28) were SRs and two (10, 26) were overviews of SRs. Majority of the SRs included studies mostly conducted in Lower Middle Income Countries (LMICS) with a few conducted in both LMICs and high income countries (HICs). Most of the studies included in the SRs were randomised controlled trials (RCTs), with some quasi-experimental study designs and observational studies.

The identified SRs and overview of SRs examined the following health systems interventions: Delivery arrangements - outreach services, the use of information and communication technology, packages of care, site of service delivery, group versus individual care, self-management, inter-professional education, role expansion or task shifting. Implementation strategies for quality of care related interventions - educational outreach visits, academic detailing, educational meetings, multifaceted continuous quality improvement, educational materials, clinical practice guidelines, audit and feedback, clinical incident reporting and community mobilisation. We did not find any systematic reviews on queuing strategies, coordination of care amongst different provider, quality and safety systems, triage, environment, size of organizations, transportation services, staffing models, exit interviews, care pathways, case management, disease management etc. (Delivery arrangements) and organisational culture, communities of practice, monitoring the performance of delivery of healthcare, local consensus process, local opinion leaders, tailored interventions etc. (Implementation strategies.) No systematic reviews on effectiveness of financing

and governance interventions in reducing NMR were found Characteristics of included SRs are summarised in [Table 2](#).

Table 2: Characteristics of included Systematic reviews

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
Lazzerini 2018	This systematic review synthesises evidence on the effectiveness of the maternal near-miss case review on quality of care and maternal and perinatal health outcomes in low-income and middle-income countries (LMICs).	RCTs, non-randomised controlled clinical trials, controlled before and after studies (CBAs), uncontrolled before and after studies (UCBAs) and intermittent time series (ITs).	LMIC	Interventions where the full audit cycle was implemented (i.e., including implementation of changes) were included,	NR	Effectiveness (outcome) on perinatal healthcare (population) of the individual NMCR cycle at facility level (intervention),	This review was funded by a grant from the GREAT Network, Canadian Institutes of Health Research, St. Michael's Hospital, Toronto.
Wondemagegn 2018	The aim of this systematic review and meta-analysis was to reveal the pooled effect of antenatal care visits on neonatal death.	No restriction	Neonates (age < 28 days)	Focused ANC follow-up	Neonates born from mothers who did not have ANC follow-up	Occurrence of death within 28 days after delivery.	None
Doig 2019	To explore the availability and	Not reported	Expectant mothers	Antenatal imaging equipment used was	Not reported	Neonatal outcomes,	No financial support was

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
	impact of point-of-care ultrasound (PoCUS) use, for antenatal care (ANC) in under-resourced settings.		undergoing ANC in a regional, rural, remote or isolated setting; Africa, Central America, Asia, Australia	described as point-of-care ultrasound, PoCUS, compact ultrasound and/or portable ultrasound		mortality, availability, accessibility, utilisation.	received for this review
DoI 2019	To determine the impact of mother-targeted mobile health (mHealth) educational interventions available during the perinatal period in low- and middle-income countries (LMICs) on maternal and neonatal outcomes.	Experimental and quasi-experimental study designs including RCTs, non-randomized controlled trials, before and after studies, and interrupted time-series studies. Analytical observational studies including prospective and	Mothers living in LMICs during the antenatal or postnatal period	Mother-targeted mHealth education interventions during the antenatal or postnatal period. mHealth interventions included mobile phones, smartphones or tablets. The mHealth intervention must have been initiated during the antenatal period (conception through birth) through six weeks postnatally, with no limitations on the frequency of contacts during or beyond this period.	Standard care (e.g., discharge education being provided in hospital) or a control group receiving an “attention” text, which was used to differentiate the effect of simply receiving a text message, regardless of the content;	First day neonatal mortality (defined as death within 24 hours after birth) Early neonatal mortality (defined as death within seven days and 42 days post-birth): Antenatal/postnatal care attendance-reported as the number of contacts.	JD is funded through a Canadian Institute of Health Research Doctoral Award to Honour Nelson Mandela (FRN154341) as a PhD in Health trainee at Dalhousie University. MCY is funded through the Canadian Child Health Clinician Scientist Program Career Development and Canadian Institute

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
		retrospective cohort studies, case-control studies and analytical cross-sectional studies were considered.					of Health Research New Investigator.
Duby 2019	To assess the effects of community-based antibiotics for neonatal possible serious bacterial infection (PSBI) in LMICs on neonatal mortality and to assess whether the effects of community-based antibiotics for neonatal PSBI differ according to the antibiotic regimen administered.	Randomised, quasi-randomised and cluster-randomised trials	Neonates born at any gestational age enrolled at any time between 0 to 27 completed days of life with possible serious bacterial infection (PSBI); community settings in LMICs	Community-based programmes of newborn care that include the initiation of antibiotics in the community for PSBI in LMICs	Standard care i.e. does not include the provision of community-based antibiotics for PSBI in LMICs	Primary outcome: Neonatal mortality rates a. Early neonatal mortality: from birth through six completed days of life b. Late neonatal mortality: between 7 and 27 completed days of life Sepsis-specific neonatal mortality - the number of neonatal deaths secondary to PSBI among all	The Division of Neonatology, University of Toronto, Canada. NHMRC Early Career Fellowship, University of Adelaide, Australia.

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
						<p>neonates during the trial period.</p> <p>a. Early neonatal sepsis-specific mortality: from birth through six completed days of life</p> <p>b. Late neonatal sepsis-specific mortality: between 7 and 27 completed days of life</p>	
Houweling 2019	To analyse the effect of community-based women's groups on neonatal mortality, health care use and home care practices in lower and higher socioeconomic strata, and tested for differences in effect between strata,	RCTs	Pregnant women; India, Nepal, Bangladesh and Malawi.	Community-based women's groups- The women's groups organized community meetings in which they explicitly asked support from the wider community for the implementation of their strategies. The strategies were meant to benefit all pregnant	Not reported	Neonatal mortality rate	This work was primarily supported by the Economic and Social Research Council and the Department for International Development (grant number ES/I033572/1). Additional support

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
	using data from four RCTs.			women, also those not attending groups.			was provided by a Wellcome Trust Strategic Award (award number: 085417MA/Z/08/Z). T.A.J.H. was also supported by an EUR Research Excellence Initiative grant.
Hutton 2019	To determine if low-risk women who intend at the onset of labour to give birth at home are more or less likely to experience a fetal or neonatal loss compared to a cohort of similarly low-risk women who intend at the onset of labour to give birth in hospital.	Not reported	Women who were at low-risk for birth complications and were intending either to give birth in hospital or home.	Home birth- 'Well-integrated' versus 'less well-integrated' home birth environment. A well-integrated setting was described as a place where home birth practitioners are recognised by statute within their jurisdiction; have received formal training; can provide or arrange care in hospital; have access to a well-established emergency transport system; and carry	Hospital birth	Perinatal or neonatal death after the onset of labour; Perinatal morality (defined as stillbirth after the onset of labour or death to 7 completed days) and neonatal mortality (defined as death between 0 and 28 days of a live born baby); Neonatal outcomes included neonatal	Partial funding: Association of Ontario Midwives open peer reviewed grant.

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
				emergency equipment and supplies. Less well-integrated settings were those where one or more of these criteria are absent. Studies were categorised by an independent team of researchers.		resuscitation, Apgar scores of less than 7 at 1 min and less than 7 at 5 min, and admission to a neonatal intensive care unit (NICU).	
Lassi 2019	To compare a community health educational strategy versus no strategy or the existing approach to health education on maternal and newborn care in LMICs, as imparted to mothers or their family members specifically in community settings during the antenatal and/or postnatal period, in terms of effectiveness for	Community-based (home, basic health unit (BHU) or first-level health facility) randomised controlled, cluster-randomised, quasi-randomised controlled trials	Women of reproductive age, pregnant women at any period of gestation, mothers of neonates (up to 28 days of life), their spouses/partners, other family members (such as mothers-in-law); LMICs	Community health education on maternal and newborn care imparted to mothers or their family members in community settings of LMICs via: 1. one-to-one-counselling; 2. group counselling (in the form of group sessions); 3. mass media (radio, television, cellular messages, newspaper, brochures, banners, etc.); Studies to be	The control did not receive the additional educational intervention or received a conventional level of health education.	Primary: Neonatal mortality The number of neonatal deaths from any cause among all live births during the trial period. 1. Early neonatal mortality: from birth through six completed days of life. 2. Late neonatal mortality: from seven to 28 completed days of life.	Aga Khan University, Pakistan; Vermont Oxford Network, USA.

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
	improving neonatal health and survival (i.e. neonatal mortality, neonatal morbidity, access to health care, and cost).			included in which mass media was introduced as a trial for a certain period or as a pilot before launching at a national level to see clear impacts of this intervention compared to control. 4. Any combination of the above.		Perinatal mortality The number of stillbirths and the number of newborn deaths within one week of life among all stillbirths and live births during the trial period.	
Magwood 2019	To synthesise and compare the evidence of the health and cost effectiveness of home-based records (HBRs) for improving maternal, newborn and child health outcomes, including empowerment outcomes for women. This study also aims to determine whether	Randomised controlled trials, prospective controlled trials, interrupted time-series (ITS) studies, cost and economic evaluation studies;	Pregnant women, mothers, or children under 10 years of age, other caregivers, and practitioners	Any form of a patient-held HBR that had impacts on maternal, newborn or child health outcomes.	Limited or no use of home-based records	Newborn health outcomes	World Health Organization and the Japan International Cooperation Agency.

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
	particular types of HBRs improve these outcomes more than others.						
Mbuthia 2019	To gather the best available evidence regarding mHealth communication to strengthen PNC in rural areas.	Randomised controlled trials, non-randomised controlled trials; qualitative and cross-sectional studies	A mother or child; Semi-urban and rural areas	mHealth communication had to be between healthcare personnel and mothers, or involved community members, mHealth communication was aimed at improving health outcomes of either a mother or child, mHealth communication was with mothers or community members from semi-urban and rural areas.	NR	Environmental constraints (access).	This review was supported by School of Nursing, University of the Free State (2016446920).
Niedzwiecka 2019	To ascertain the impact of ventilator bundles on the incidence of ventilator-associated pneumonia in mechanically	Randomised controlled trials (RCTs), noncontrolled trials and observational studies (e.g.,	Neonates and children up to 18 years of age receiving mechanical ventilation; Hospital	Ventilator care bundles that include interventions such as oral hygiene, elevation of the head of the bed, clean endotracheal suctioning, minimal	Standard patient care with no ventilator bundles implemented in practice or	Mortality rates; ventilator-associated pneumonia (VAP) rates post implementation of care bundles;	Not reported

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
	ventilated neonates and children in intensive care units.	nonrandomised experimental studies, case-control and cohort studies)		ventilator circuit changes and the use of H2-receptors.	no interventions.	number of PICU days, the number of mechanical ventilator days.	
Tiruneh 2019	To evaluate the effectiveness and cost-effectiveness of home-based postnatal care on exclusive breastfeeding practice and neonatal mortality in low-and-middle income countries.	Randomized trials and quasi-experimental studies	Mother and newborn; Community based	Postpartum home-based interventions—including counselling; examination and management; and provision of services—provided to women and newborns in the first six weeks after birth at home by health providers or community health workers. Home-based treatment for illness, community mobilization efforts, and any home-based/community-based neonatal interventions, were	Routine postnatal care provided to mothers who delivered in a health facility on discharge or care provided after discharge within six weeks when the women visited the facility.	Neonatal mortality—neonates who died within the first 28 days of life.	None

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
				considered as home-based postnatal care.			
Van Veenendaal 2019	To assess the difference in effect of hospitalisation in single family rooms versus open bay units in preterm infants, primarily on long term neurodevelopmental outcome.	Randomised clinical trials, cohort studies, quasi-experimental studies, and before and - after series	Preterm infants; Hospital based	Single family rooms	Open bay units	Mortality- death during hospital stay as reported or calculated from flowcharts;	None
Ameh 2019	To review the evidence for the effectiveness of training in Emergency Obstetric Care	Systematic reviews with a mix of RCTs and cohort studies, RCTs and cohort studies, before- after studies, longitudinal and retrospective studies and qualitative studies	Healthcare providers from HICs and LMICs	In-service EmOC training programmes or courses	Onsite vs simulation, Longer Vs shorter training duration	Neonatal mortality rate, Peri-natal mortality rate	World Health Organization and the Department for International Development United Kingdom who funded the Making it Happen programme [Contract 202945-101].

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
Bekele 2019	The aim of this review is to generate the best existing evidences concerning the Maternity Waiting Homes (MWHs) utilization and its impact on perinatal mortality (PNM) among pregnant mothers in Africa	Cross sectional, case-control, cohort studies	Pregnant mothers	Maternity waiting homes	Not reported	Utilisation of maternity waiting homes and perinatal mortality	None
Versantvoort 2019	The aim of this systematic review is to present an overview of the available evidence regarding intrapartum-related stillbirths and neonatal mortality in relation to the HBB training and resuscitation method as an intervention on its own	No restriction	Studies conducted in low-resource settings focusing on the association between Helping Babies Breathe and intrapartum-related stillbirths and/or neonatal mortality were included.	Weekly peer to peer resuscitation skills practice, initial training and refresher training between 6 months and 230 days follow up, self-evaluation after every delivery and peer evaluation after every resuscitation	No comparator included	Intrapartum-related stillbirths: Birth of a foetus with an Apgar score of 0 by 1 and 5 min, with no signs of maceration and suspected dying during labour. 1-day mortality: all deaths of live-born infants within 24 hours after birth.	None

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
						7-day mortality: all deaths of live-born infants within in the first week of life. 7–28-day mortality late mortality: all deaths of live born infants between the first week and first month of life. 28-day mortality- all deaths of live-born infants within in the first month of life.	
Ricchi 2019	To verify whether there are proofs of effectiveness that support the caseload midwifery care model, and if it is possible to apply this model in the birth path in Italy.	Systematic revisions, observational and/or experimental studies, qualitative studies concerning the patients' and/or the operators'	Pregnant women; NR	A project managed independently by midwives, on a care model for pregnancy, delivery, puerperium and low-risk infants	Standard models.	Foetal loss/neonatal deaths before 24+0 weeks;	NR

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
		satisfaction, descriptive and transversal studies.					
Rohwer 2020	To determine the relative benefits and risks of individual patient protocols, health service policies, educational interventions or other strategies which aim to optimise the use of antenatal corticosteroids (ACS) for anticipated preterm birth.	Cluster-randomised controlled trials (RCTs); individually-randomised and quasi-randomised trials	Women at risk of preterm birth and their babies	Strategies to optimise the use of ACS, including: 1. strategies aiming to promote the use of ACS; 2. strategies aiming to restrict the use of ACS. Strategies considered included but were not limited to the following: 1. education and training; 2. health service policies; 3. treatment protocols.	1. Strategies to promote ACS use versus usual care 2. Strategies to restrict ACS use versus usual care 3. Comparison of various strategies	Primary outcomes Perinatal death (as defined by trial authors) Neonatal death	The National Institute for Health Research, via Cochrane Infrastructure funding to Cochrane Pregnancy and Childbirth

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
Morris 2020	To identify challenges, knowledge gaps, and successes associated with each stage of Helping babies breathe programming.	All articles related to HBB, in any language, were included.	All articles related to HBB, in any language, were included.	Helping Babies Breathe (HBB)	NR	Neonatal mortality rate, Peri-natal mortality rate	None
Palmer 2020	To assess the effects of Targeted client communication (TCC) via mobile devices (MD) on health behaviour, service use, health, and well-being for MNCH.	Randomised controlled trials	pregnant and postpartum women up to six weeks after birth living with/without HIV, and their partners. Parents and carers of children aged under five years	Trials that assessed TCC delivered via mobile devices,	Usual care/no intervention, non-digital TCC, and digital non-targeted client communication	Service utilisation- ANC, intrapartum care, postnatal care, postnatal care of newborn;	UNDP-UNFPA-UNICEF-WHO World Bank Special Programme of Research, Development and Research Training in Human Reproduction (HRP), a cosponsored program executed by the World Health Organization (WHO).

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
Peven 2020	<p>1. identify and describe which implementation strategies and outcomes are reported for implementing ENC interventions in low and- middle-income countries</p> <p>2. determine the relationship between implementation strategies and coverage of ENC interventions in low- and low middle-income countries.</p>	Empirical quantitative and qualitative study designs	Interventions targeting healthy newborns in the first hour (for facility-based interventions) or day (for community-based interventions) of life in low- and low middle-income countries were included.	Studies examining the implementation of ENC interventions (immediate and thorough drying, immediate SSC, delayed cord clamping and early initiation of breastfeeding) were eligible if they were implemented within the first hour of life for facility-based interventions, and the 1st day of life for community-based interventions, as neonatal mortality is highest in this time frame and most recommended ENC interventions are intended to be implemented immediately after birth.	No comparator included	Coverage	King's College London, Centre for Doctoral Studies [Health Faculties US Scholarship]. This article is part of the supplement 'innovations in Implementation Research in Low- and Middle-Income Countries', a collaboration of the Alliance for Health Policy and Systems Research and Health Policy and Planning. The supplement and this article were produced with financial support from the Alliance for Health Policy and Systems Research.

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
Questa 2020	An umbrella review to identify approaches to Community Engagement in communicable disease control, effectiveness of these approaches, mechanisms and factors influencing success.	Considered reviews of any type of study design, with any comparison group.	Adult members of the community (e.g lay persons, community volunteers, community leaders) from low or lower middle income countries.	Community engagement interventions for communicable disease control.	No criteria against control groups were applied.	Neonatal Mortality	Economic and Social Research council, UK.
Tolu 2020	The objective of this review was to locate international literature reporting on the effectiveness of utilizing the WHO safe childbirth checklist on improving essential childbirth practices, early neonatal death, stillbirth, maternal mortality, and morbidity.	Randomized controlled trials (RCTs), and, before and after studies	Health professionals directly involved in the care for mothers and newborns during labour, delivery, and post-partum periods and mothers and newborns in any health care settings	Utilization of the WHO safe childbirth checklist by health professionals.	Labouring mothers and newborn care without WHO safe childbirth or any other structured checklist.	Essential childbirth practices, early neonatal death.	None

Citation	Review objective	Types of Study Designs included in SRs	Population and setting	Intervention	Types of Comparator	Outcome	Funding
Willcox 2020	To assess the impact and cost-effectiveness of different types of death audits and reviews in reducing maternal, perinatal and child mortality.	Cluster nonrandomised trials, studies with a step-wedge design, controlled before-and-after studies and interrupted time series studies	Mothers delivering in the hospitals	Any form of death audit or review that involved studying individual cases of maternal, perinatal or child deaths, identifying avoidable factors and making recommendations.	No comparator included	Primary Outcomes Perinatal mortality rate (stillbirth or death of a newborn baby within the first seven days of life); Neonatal mortality rate (number of babies who die from 0 to 28 days per 1000 live births);	NIHR, UK.

Table 3: Summary of evidence for health system interventions

EPOC Intervention Category (MAJOR)	EPOC intervention Category (Minor)	Intervention Versus Comparator (if available)	Number of reviews	Summary of evidence for outcomes
Delivery arrangements	Outreach services	<ul style="list-style-type: none"> Point-of-care ultrasound (PoCUS) imaging equipment services AnteNatal Care (ANC) visits and follow up versus no ANC visits 	02	<ul style="list-style-type: none"> Reduction in neonatal mortality rate was observed in the intervention group and neonatal deaths at the time of delivery were averted by PoCUS utilisation. ANC visits decreased the risk of neonatal mortality.
	The use of information and communication technology	<ul style="list-style-type: none"> mHealth intervention versus standard care. mHealth communication- phone calls, one-way messaging, interactive messaging, audiovisual material and videos, voice messages, and combined messaging and phone calls; Targeted client communication via mobile devices 	03	<ul style="list-style-type: none"> No significant difference in first-day newborn mortality. Significant reduction in early NMR- for the SMS intervention group compared to standard care. Improved access to the antenatal visits by women in the intervention compared to control – not statistically significant.
	Packages of care	<ul style="list-style-type: none"> Community-based programmes of newborn care that include the initiation of antibiotics in the community for possible serious bacterial infection (PSBI) in LMICs versus community-based 	02	<ul style="list-style-type: none"> Reduced Neonatal mortality Reduced early neonatal mortality Reduced late neonatal mortality Reduced Sepsis-specific neonatal mortality Ventilator associated pneumonia mortality rate reduced:

		<p>programmes that do not include the provision of community-based antibiotics</p> <ul style="list-style-type: none"> • Ventilator care bundles elements versus standard care 		<p>However, the statistical significance was not achieved (P value = .215).</p>
	Site of service delivery	<ul style="list-style-type: none"> • A well-integrated and Less well-integrated settings (home birth) Versus Hospital birth. • Antepartum and postpartum home visits Versus usual or Routine hospital/facility based care without home visit in the postpartum period care. • Single family rooms Versus Open bay units • Maternity waiting homes (MWH) 	04	<ul style="list-style-type: none"> • In Midwives well-integrated health services- no difference in NMR • In Midwives less-integrated health services setting- favoured hospital birth • Home-based PNC reduced neonatal mortality. More than three PNC home visits contributed to reduction in neonatal mortality than trials with less than three PNC home visits. Home visits by community health workers were associated with better survival of neonates than visits by health professionals. Community mobilization efforts with home visits to promote newborn care practices helped reduced neonatal mortality than home visits alone. • NMR- No difference • Utilizing MWHs have a significant effect in a reducing Perinatal mortality. There is a significant association between MWH utilization and perinatal mortality.
	Group versus individual care	<ul style="list-style-type: none"> • Community health educational interventions; 	01	<ul style="list-style-type: none"> • Overall neonatal mortality- reduced • Early neonatal mortality- reduced • Late neonatal mortality- reduced • Perinatal mortality- reduced

		Interventions were provided either one-to-one counselling, Group counselling or both.		<ul style="list-style-type: none"> • Access- increased utilisation of any antenatal care <p>Subgroup analysis</p> <ul style="list-style-type: none"> • One-to-one counselling- non-significant impact on neonatal mortality • Group counselling- reduced neonatal deaths • Both the methods- did not significantly reduce neonatal mortality • Educational interventions delivered during both antenatal and postnatal periods- reduced neonatal deaths • Education delivered during the antenatal period- no impact on NMR • Education delivered during the postnatal period- no significant impact on neonatal mortality
	Self management	<ul style="list-style-type: none"> • Maternal and Child Health handbook Versus no use of home-based records Children. 	01	No statistical effects of HBRs on newborn outcomes
	Role expansion or task shifting	<ul style="list-style-type: none"> • Midwifery led care model versus other models 	01	<ul style="list-style-type: none"> • NMR- Reduction • Foetal loss/neonatal deaths before 24+0 weeks- Reduction

Implementation strategies	Inter-professional education	<ul style="list-style-type: none"> • Helping Babies Breathe (HBB)- neonatal resuscitation program; • 	02	<ul style="list-style-type: none"> • Significant decreases in 24-hour perinatal mortality and all-cause 24-hour neonatal mortality • No difference in 7-day newborn mortality and 28-day mortality rates •
	Educational meetings, Educational outreach visits, or academic detailing	<ul style="list-style-type: none"> • Training on essential newborn care in community and facility setting. • Training on conducting maternal death reviews • Training in emergency obstetric care (EmOC) 	04	<ul style="list-style-type: none"> • Coverage- No relationship between coverage and strategy importance ratings or number of strategies used • Overall perinatal mortality- no difference Neonatal mortality within 24 hrs- reduced • Neonatal deaths and 7-day neonatal mortality rate- significant reduction
	Continuous quality improvement; Educational materials; Educational meetings	<ul style="list-style-type: none"> • Multifaceted strategies which included training in neonatal care and a recommendation to refer women at high risk of preterm birth to hospitals. Educational interventions which aim to optimise the use of antenatal corticosteroids 	01	<ul style="list-style-type: none"> • Risk of perinatal death and neonatal death before 28 days at population level- Increased

	Clinical Practice Guidelines	<ul style="list-style-type: none"> • WHO safe childbirth checklist 	01	<ul style="list-style-type: none"> • Early neonatal death- No significant difference
	Audit and feedback, Clinical incident reporting	<ul style="list-style-type: none"> • The maternal near-miss case review audit 	01	<ul style="list-style-type: none"> • Perinatal deaths- No significant difference
	Community Mobilisation	<ul style="list-style-type: none"> • Women's groups practicing a participatory learning and action approach 	01	<ul style="list-style-type: none"> • Neonatal mortality- Reduction
	Outreach Services, Community mobilisation	<ul style="list-style-type: none"> • Participatory learning and action groups, community meetings, home visits to pregnant women 	01	<ul style="list-style-type: none"> • Neonatal mortality- reduced across all the groups • Early and Late Neonatal mortality- reduced across all the groups (most marginalized' 'less marginalized')

Summary of findings from the included systematic reviews on health systems interventions

A narrative overview of the findings from the included SRs is presented in a structured manner based on the EPOC health systems intervention categories in [Table 3](#).

Delivery arrangements

Overall, 14 SRs were included in this domain that involved over 18,60,902 participants who were pregnant women, neonates (aged 0 to 27 days) and mothers. One hundred and twenty eight studies in fourteen SRs examined the effects of various health systems interventions related to delivery of care on various neonatal care related outcomes. Overall reviews have largely assessed neonatal mortality rate, peri-natal mortality rate and death in neonates due to any specific cause.

Majority of the studies included in the SRs used RCTs, cluster- RCTs, and quasi-experimental designs. The studies were conducted mainly in LMICs like India, Pakistan, Nepal, Bangladesh, Cambodia, Indonesia, Mongolia, Guatemala, Syria and some other Asian and African countries. Some studies were conducted in a few high and middle income countries like Netherlands, England, Iceland, Canada, the United states (US), New Zealand, Norway, Sweden, Japan, Australia.

Outreach services

Two SRs (24, 27) identified 20 studies that examined the effect of outreach services on neonatal mortality rate.

Point-of-care ultrasound (PoCUS) imaging equipment services

A SR examined the impact of PoCUS use for ANC on NMR.(24) Methodologically, this SR was found to be of critically low confidence in result of SR on using AMSTAR-2 checklist. Overall, two studies (prospective cohort and cross-sectional study) conducted in Central America and Asia respectively were included. The PoCUS is used as a viable technology to mitigate the challenges due to the low outright and maintenance costs, portability, compact size, simple use, minimal requirements for use and the many potential applications. The intervention also included advertising the availability of PoCUS and using them during the ANC visits.

A 64% reduction in NMR was reported in the intervention group in comparison with the control group (a study conducted in Central America) while another study reported 14.6% neonatal deaths at the time of delivery were averted by PoCUS utilisation (a study conducted in Asia);

ANC visits and follow up

Another SR examined (Low confidence in result of SR) the effect of ANC visits on neonatal death (27). Eighteen observational studies (cross sectional, cohort, case-control) conducted in African and Asian LMICs were included in the review. Antenatal Care visits included teaching mothers on identifying early warning signs of complications during pregnancy, labour, and delivery. These visits also provided information on postpartum care, newborn care, breastfeeding, problem signs, and what appropriate action to be taken.(27)

The study reported a pooled effect size of neonatal death among those live births born to mothers who had ANC visits was [Relative Risk [RR= 0.66 (0.54 to 0.80; 18 studies)] compared to those born to mothers without having ANC visits. The finding of the present SR and meta-analysis revealed that ANC visits decreased the risk of neonatal mortality by 34%. The result obtained from the subgroup analysis indicated that 41% of neonatal mortality in Sub-Saharan African countries could be prevented through the implementation of ANC.(27)

The use of information and communication technology

The use of information and communication technology as an intervention was reported in three SRs (12, 18, 23). The SRs identified seven studies of which six were RCTs and one was quasi-experimental study. The various interventions examined mobile health (mHealth) interventions and communications, and Targeted client communication (TCC) via mobile devices (MD).

Mobile health interventions and communications

Two SRs (critically low confidence in result of SR using AMSTAR-2) examined the impact of mother-targeted mHealth educational interventions available during the perinatal period and postnatal period (PNC) on neonatal outcomes and access to health services (18, 23).

Systematic review by Dol et al. (2019) reported studies primarily utilising SMS as reminders to increase the number of perinatal care contacts that mothers made. While other studies reported using voice calls via mobile phone. The frequency of messages ranged from one mobile phone call educational sessions- seven to 148 messages during the antenatal period. The content of the messages also varied widely and included both unidirectional and bidirectional interaction. Many of the antenatal SMS interventions were adapted based on gestational age of the foetus at enrolment. The evidence suggested no significant difference in first-day newborn mortality between mothers in the intervention (1.0%) and control groups [(3.4%), P =0.269; Very low quality of evidence using GRADE)] i.e. standard care. Early NMR- significant reduction

for the SMS intervention group compared to standard care [adjusted OR= 0.50 (0.27 to 0.93; P value not reported; 2 studies; moderate quality of evidence using GRADE)].(23)

Another SR by Mbuthia et al (2019) used mHealth communication - phone calls, one-way messaging, interactive messaging, audio-visual material and videos, voice messages, and combined messaging and phone calls. Phone calls were used by healthcare practitioners (HCPs) to remind mothers to attend PNC clinics and to inform them of their laboratory results; one-way mobile phone messaging was used by HCPs to remind mothers of clinic appointments, communicate test results from the clinic and to give them information on PNC; interactive mobile phone messaging between HCPs and mothers was used to discuss breastfeeding practices and remind mothers to attend PNC clinics; mobile phone audio visual application and educational videos was sent to mothers by HCPs to illustrate various PNC practices; A combination of one way mobile phone messaging and phone calls was used by HCPs to remind mothers about their clinic appointment dates; voice messages were delivered to mothers by HCPs to inform them of neonatal care; the study reported an improved access to the antenatal visits by women- 85% in the intervention compared to 71% in control, however the result was statistically insignificant.(18)

Targeted client communication (TCC) via mobile devices (MD)

One SR conducted by Palmer et al (High confidence in result of SR) assessed the effects of TCC via mobile devices on health behaviour, service use, and health and well-being for maternal, new-born and child health. The SR reported four RCTs using targeted client communication via mobile devices. The interventions aimed to provide information, education, or support. Few also provided reminders alongside information/ education or support through text messages, via phone calls, and a combination of these. However, results of pooled analysis of the RCTs for neonatal mortality was consistent with no effect [OR=1.00 (0.61 to 1.64; 4 studies; low quality evidence on GRADE)].(12)

Packages of care

Two systematic reviews (17, 22) looked at packages of care as an intervention, which mainly included community-based programmes of newborn care and ventilator care bundles.

Community-based programmes of newborn care

The SR by Doby et al (moderate confidence in result of SR) included five RCTs which assessed effects of community-based antibiotics for neonatal Possible Serious Bacterial Infection (PSBI), in neonates (aged 0 to 27 days), on neonatal mortality. The programme included the initiation of antibiotics in the community for PSBI. It also included early identification of pregnancy, provision of focused antenatal care,

promotion of institutional delivery, safe and clean delivery, recognition of asphyxia, resuscitation of the newborn baby, prevention and management of hypothermia, management of preterm and low-birthweight neonates, education on neonatal care and signs of illness. (22)

The pooled estimates reported community-based antibiotic delivery for neonatal PSBI reduced neonatal mortality [RR 0.82 (0.68 to 0.99; $P < 0.0001$; 5 studies; low-quality evidence)]. The intervention showed a possible effect on reducing early neonatal mortality [RR 0.74 (0.65 to 0.85; $P = 0.29$; 5 studies; moderate-quality evidence on GRADE)]. Two of the five RCTs assessed neonatal mortality after the first week of life and reported reduction in late neonatal mortality [RR 0.73 (0.55 to 0.96; $P = 0.30$; 2 studies; moderate-quality evidence on GRADE)], (Community-based antibiotic delivery for PSBI in neonates showed a possible effect on reducing sepsis-specific mortality [RR 0.78 (0.60 to 1.00; $P = 0.84$; 5 studies; low-quality evidence)].

Ventilator care bundles

Another systematic review by Niedzwiecka et al (critically low confidence in results of SR) which included a before-and-after intervention prospective study, assessed the impact of ventilator bundles on the incidence of pneumonia in mechanically ventilated neonates and children in intensive care units. The ventilator care bundle elements comprised of: head of the bed elevation, mouth care, daily assessment of readiness to extubate, intubation and equipment management. The number of interventions per ventilator bundle in the studies ranged from four to nine. (17)

The study demonstrated that the incidences of Ventilator Associated Pneumonia (VAP) in mechanically ventilated neonates were found to be reduced by the use of ventilator bundles.

The overall ventilator associated pneumonia mortality rate post implementation of a ventilator bundle was reported as 16 (25%) in the Phase I whereas in Phase II it further reduced to 14 (17.3%). However, the statistical significance was not achieved (P value = 0.215).

Site of service delivery

Site of service delivery was reported as a health systems intervention in four SRs. (14, 15, 20, 25) Various interventions examined included home birth versus hospital birth, home-based antepartum and postnatal care, single family rooms versus open bay units and maternity waiting homes.

Home birth versus hospital birth

A systematic review by Hutton et al (critically low confidence in result of SR) included fourteen retrospective and prospective cohort studies included in meta-analysis. The studies conducted in HICs determined if risk of foetal or neonatal loss differed among

low-risk women who began labour intending to give birth at home compared to low-risk women intending to give birth in hospital. (20)

The review described home birth as a 'well-integrated' versus 'less well-integrated' home birth environment. A well-integrated setting was described as a place where home birth practitioners are recognised by statute within their jurisdiction, have received formal training, can provide or arrange care in hospital, have access to a well-established emergency transport system and carry emergency equipment and supplies. Less well-integrated settings were those where one or more of these criteria are absent. Midwives attending home birth were considered to be well-integrated into the healthcare system (The Netherlands, England, Iceland, Canada, USA, New Zealand) whereas, midwives attending home birth were considered to be less well-integrated into the healthcare system (Norway, Sweden, Japan, Australia).

The primary outcome reported was NMR. There was no difference in the primary outcome between those who intended delivering in midwives well-integrated health services setting and those who intended hospital birth when data from studies were pooled for nulliparas [OR 1.07 (0.70 to 1.65)] and multiparas women [OR 1.08 (0.84 to 1.38)]. In less-integrated among nulliparous women [OR 3.17 (0.73 to 13.76)] and multiparous women [OR 1.58 (0.50 to 5.03)] favoured hospital birth.

Home-based antepartum and postnatal care

Another systematic review by Tiruneh et al (low confidence in result of SR) identified seven cluster RCTs, one each RCT and quasi experimental studies evaluating the effectiveness of home-based antenatal and postnatal care on neonatal mortality in India, Pakistan and Bangladesh. (15)

The intervention assessed was antepartum and postpartum home visits versus usual or routine hospital/facility based care without home visit in the postpartum period care. It also included community activities in addition to home visits to promote optimal neonatal care practices and treatment of sick neonates; community-wide meetings; community health workers (CHWs) provided preventive & promotive package of interventions for essential newborn care (birth preparedness, clean delivery, and cord care, thermal care, breastfeeding promotion, and danger sign recognition). Intervention was provided by CHWs, community-based surveillance volunteers (CBSVs), Lay Health Workers (LHW), local resident women with eight grade of formal education and Peer counsellors. These were trained between three days to 18 months. Each trial had an average of four postpartum home visits and an average of one antepartum visit (usually at third trimester). Follow-up period ranged from one to 24 weeks postpartum.

Home-based PNC reduced neonatal mortality by 24% [RR 0.76 (0.62 to 0.92; P = <0.01; 9 studies, moderate quality evidence on GRADE)). Results from the subgroup analysis reported that more than three PNC home visits contributed to reduction

in neonatal mortality [RR 0.70 (0.53 to 0.91) than trials with less than three PNC home visits [RR 0.77 (0.61 to 0.98; P = .043)]. Home visits by community health workers were associated with better survival of neonates [RR 0.69 (0.55 to 0.87)] than visits by health professionals [RR 1.26 (0.37 to 4.30; P = .001)]. Community mobilization efforts with home visits to promote newborn care practices helped reduce neonatal mortality [RR 0.69 (0.54 to 0.88)] than home visits alone [RR 0.97 (0.90 to 1.05; P = .001)].(15)

Single family rooms versus open bay units

A systematic review (low confidence in result of SR) examined the difference in effect of hospitalisation in single family rooms versus open bay units in preterm (mean gestational age <28 weeks) infants on neonatal outcome. The SR identified seven studies of various designs - four before and after studies, two non-RCTs and one RCT. The intervention included neonates hospitalised in single family rooms compared with common open bay units. No difference was found for neonatal mortality [RR=1.00 (0.79 to 1.28; P=0.990)]. (14)

Maternity waiting homes

Another SR by Bekele et al (2019) (critically low confidence in result of SR) identified five prospective, retrospective cohort and cross-sectional studies assessing the impact of maternity waiting homes (MWHs) utilization on perinatal mortality (PNM) among pregnant mothers in Africa. MWHs is a strategy especially for communities who were unable to reach facility easily for delivery and postpartum services. It is a facility where pregnant mothers, especially who are from hard to reach areas stay until their date of delivery.(25)

Meta-analysis revealed that utilizing MWHs have a significant effect in a reducing perinatal mortality by 82.5% (80.4% to 84.5%), [OR 0.175 (0.155 to 0.196)]. Sensitivity analysis was done, and it resulted in Q test (p < 0.001). Thus, there is a significant association between MWH utilization and PNM.

Group versus individual care

Group versus individual care was reported by one systematic review (High confidence in result of SR) focussed on comparing a community health educational strategy versus no strategy or the existing approach to health education on maternal and newborn care in LMICs. This SR by Lassi et al identified 33 RCTs and quasi-randomised controlled trials conducted across Africa and Central and South America, with most reported from Asia, specifically India, Pakistan, and Bangladesh.(1)

The SR examined the effectiveness of community health educational interventions. Education was a component of the intervention and was used in conjunction with other interventions. Interventions were provided either one-to-one counselling, group counselling or both; interventions included promotion of routine antenatal care, tetanus toxoid immunisation, nutrition counselling including iron folic acid supplementation,

maternal health education, promotion of institutional deliveries, birth and newborn care preparedness, provision of safe delivery kits, clean delivery practices, referrals for emergency obstetrics care, promotion of early and exclusive breastfeeding, kangaroo mother care, newborn resuscitation, management of neonatal infections, referrals for sick newborns, and postnatal visitation and recognition of neonatal danger signs.

Community health educational interventions had a significant impact on reducing overall neonatal mortality [RR 0.87 (0.78 to 0.96; $P < 0.00001$; 26 studies; low-quality evidence on GRADE)]. Community health education interventions showed a significant impact on reducing early neonatal deaths by 26% [RR 0.74 (0.66 to 0.84; $P < 0.00001$; 15 studies; very low-quality evidence on GRADE)] and late neonatal mortality by 46% [RR 0.54 (0.40 to 0.74); $P < 0.00001$; 11 studies; very low-quality evidence)]. Perinatal mortality was reduced by 17% [RR 0.83 (0.75 to 0.91; $P < 0.00001$; 15 studies; very low-quality evidence on GRADE)]. There was also increased access of any antenatal care [RR 1.16 (1.11 to 1.22; 18 studies; $\text{Chi}^2 P < 0.00001$)].

Sub-group analysis of neonatal mortality reports one-to-one counselling had a non-significant impact on neonatal mortality [RR 0.92 (0.71 to 1.20; $P < 0.00001$; 8 studies; very low-quality evidence on GRADE)]. Education through group counselling managed to reduce neonatal deaths by 17% [RR 0.83 (0.74 to 0.92; $P < 0.00001$; 12 studies; low-quality evidence on GRADE)]. However, both the methods used for each woman did not significantly reduce neonatal mortality [RR 0.90 (0.76 to 1.06) $P < 0.00001$; 6 studies; moderate-quality evidence on GRADE)].

Educational interventions delivered during both antenatal and postnatal periods managed to reduce neonatal deaths by 15% [RR 0.85 (0.76 to 0.96; $P < 0.0000$; 20 studies; very low-quality evidence on GRADE)]. Education delivered during the antenatal period had no impact on NMR [RR 0.84 (0.64 to 1.09; $P < 0.0001$; 3 studies; very low-quality evidence on GRADE)]. Education delivered during the postnatal period had no significant impact on neonatal mortality [RR 1.02 (0.84 to 1.24; $P = 0.03$; 3 studies; low-quality evidence on GRADE)].(1)

Self-management

One systematic review (low confidence in result of SR) looked at self-management as an intervention, which mainly included home-based record intervention. The SR identified two studies RCT and cluster randomised trials each conducted in UK and Mongolia respectively. The studies examined effectiveness of home-based records (HBRs) for improving newborn outcomes. (19)

Maternal and Child Health handbook contained a log for recording information on maternal health and personal information, course of pregnancy, delivery and postpartum health, weight during and after pregnancy, dental health, parenting classes, child development milestones from the ages of 0–6 years, immunization and illnesses, and height and weight charts for children, woman-held maternity case notes.

Findings suggest no statistical effects of HBRs on newborn outcomes. Maternal and Child Health handbooks had no effects compared to the unspecified pre-existing system in the control group on neonatal death or stillbirths [RR 1.0 (0.99 to 1.01; $p = 0.512$; 2 studies; moderate quality evidence)]. Full pregnancy case notes had no effect, compared to a briefer 'co-op card', on neonatal death [RR 1.04 (0.15 to 1.21; 2 studies; very low quality evidence)] no statistical effects of HBRs on newborn outcomes.(19)

Role expansion or task shifting

A systematic review (critically low confidence in result of SR) conducted in Italy assessed the effectiveness of the caseload midwifery care model on various clinical outcomes. The review identified 13 studies of systematic review, randomised controlled trials and observational design involving 17561 pregnant females.

Midwifery led care model focused not only on the caring process based on the obstetric risk, but also on the continuity of patient care understood as a continuum of delivery and support throughout the birth path. Women are followed by a group of midwives (usually 6 or 7) who can alternate with each other. A woman may receive assistance during pregnancy, during childbirth and after childbirth from different midwives.

The results reported were from the identified systematic review of 15 randomized controlled trials carried out in Australia, Canada, Ireland, United Kingdom by Sandall and Coll, which compared Midwife-led continuity models versus other models of care for childbearing women. The women assisted by a midwife of the caseload have had lower risk of fetal loss/neonatal deaths before 24+0 weeks [RR 0.81 (0.67 to 0.98)] and NMR [RR 0.84 (0.71 to 0.99)].

Implementation strategies

Systematic reviews and overview of SRs included in this RES identified various implementation strategies that aimed at assessing the effectiveness of various health system interventions. Overall, nine SRs and two overviews of SR included in this domain. Most initiatives used multiple implementation strategies, and the results showed that a combination of multiple strategies was more effective compared to using a single strategy.

Inter-professional education

Two systematic reviews (both critically low confidence in result of SR) examined the effectiveness of Helping Babies Breathe (HBB) training programming and its impact on neonatal outcomes. The systematic review by Morris et al identified ten before-and-after cohort study and a systematic review by Dol et al conducted in India, Nepal and other African countries.(13) Another SR by Versantvoort et al which identified ten cohort studies conducted in India, Nepal, Sudan, Kenya and Tanzania.(7)

Helping Babies Breathe is a neonatal resuscitation program which involved HBB training along with other neonatal interventions. It comprised of on the job training to different healthcare professionals or assisting medical officer, midwives, operating nurse, nursing student and ward attendants by trained staff. It involves weekly peer to peer resuscitation skills practice, with weekly reflection meetings. The initial training period ranged from one to three days followed by refresher training between 3-6 months and 230 days follow up and a self-evaluation after every delivery and peer evaluation after every resuscitation.

There was mixed evidence from eleven studies reported in Morris et al on the effectiveness of HBB training programme. A study conducted in Tanzania reported Helping Babies Breathe (neonatal resuscitation programme) implementation was associated with a 47% reduction in all-cause 24-hour neonatal mortality. Frequent and brief on-site HBB training at a Tanzanian rural referral hospital was associated with a decrease in 24-hour mortality from 11.1 to 7.2 per 1000 ($P = .040$). Similarly, after HBB training, there was a 73% reduction in perinatal mortality, 88% reduction in 24-h newborn mortality reported in a study conducted in Mali. Another Before and after cohort study from Nepal reported in-hospital reduction of neonatal death due to intrapartum related complications (51%–33%), increasing survival-days of preterm newborns, and significant decrease in first 24-hour mortality after HBB training. A Study conducted in Southern India however displayed no difference in NMR. Despite a significant decrease in 24-hour neonatal mortality, researchers in another Indian study saw no difference in 7-day newborn mortality. The results from the identified systematic review by Doll et al that included 17 studies on HBB, reported a significant reduction in 24-hour mortality rates [OR 0.70 (0.51 to 0.98; 17 studies)]; however, there was no measurable impact on 7-day mortality rates [OR 0.87 (0.70 to 1.08; 17 studies)], 28-day mortality rates [OR 1.09 (0.80 to 1.47; 17 studies)].(13)

The results reported by Versantvoort et al (2020) showed significant decreases after the implementation of HBB in one of two studies describing perinatal mortality rate from 30.9/1000 births to 23.3/1000 births [RR 0.75; $p < 0.001$]. Four out of five studies reported reduction in 1 day neonatal mortality [RR 0.37–0.67 ($p < 0.001$, $p = 0.04$; 4 studies)].(7)

Educational meetings, Educational outreach visits, or academic detailing

Educational meetings and educational outreach visits was examined in three SRs and an overview of SR. The interventions examined primarily included various training on various aspects like training of lay or auxiliary health care workers in essential newborn care (ENC), training on conducting maternal death reviews, training in emergency obstetric care (EmOC).(6, 9, 11, 26)

Training on essential newborn care in community and facility setting

A systematic review (critically low confidence in result of SR) by Peven et al (2020) aimed at determining the relationship between implementation strategies and coverage of ENC interventions in low- and low-middle income countries. The SR identified 27 studies which reported coverage as an outcome. (11)

Interventions implemented in community setting involved training of lay or auxiliary health care workers (paid or volunteer) to conduct home visits, provide home-based newborn care or support home-based ENC. Facility interventions mostly included training for medically qualified facility staff, implementation of checklists or job aids (e.g. pictorial counselling cards), and implementation of the Baby Friendly Hospital Initiative (BFHI). The time between implementation and the final follow-up reported in the study ranged from <1 month to 10 years, with a median of 2 years. Few interventions were conducted in mixed setting. Training was mainly provided by Ministry of Health (Central and State), Universities, and through mixed delivery by both university and government.(11)

The study reported no relationship between coverage and strategy importance ratings or number of strategies used ($r=0.4$, $P=0.77$ and $r=0.15$, $P=0.3$, respectively). Standardized effect sizes (Cohen's d) ranged from -1.26 to 2.23.

Training on conducting maternal death reviews

Another systematic review (high confidence in result of SR) by Wilcox et al examined impact of different types of death audits and reviews in reducing maternal, perinatal and child mortality. The review identified two trials- The QUARITE study (QUALity of care, RIsk management, and TEchnology) concerned maternal death reviews in hospitals in West Africa and The OPERA trial, conducted in France.(6)

Both the trials introduced death review and audit as part of a complex intervention, which had different components. In the QUARITE study (QUALity of care, RIsk management, and TEchnology) the intervention focused on training leaders of obstetric teams in capital, regional and district hospitals using the ALARM (Advances in Labour And Risk Management) international course, which included one-day training on conducting maternal death reviews. The leaders then returned to their hospitals where they established a multidisciplinary committee and started auditing maternal deaths, with the support of external facilitators every quarter. Whereas in the OPERA trial the intervention started with an outreach visit to brief obstetricians, midwives and anaesthetists on the national guidelines on morbidity/mortality case management and was followed by a series of morbidity/mortality conferences (MMCs). Half of the intervention units were randomised to receive additional support from a clinical psychologist during these meetings.(6)

OPERA trial reported little or no difference to overall perinatal mortality in this setting [OR 1.05 (0.91 to 1.21; low quality evidence on GRADE)]. The QUARITE intervention probably reduced inpatient neonatal mortality within 24 hours of birth [adjusted OR 0.74 (0.61 to 0.90; moderate quality evidence on GRADE)] Neonatal mortality within 24 hours dropped from 11.6 to 9.7 deaths per 1000 births in hospitals receiving the QUARITE intervention, compared to an increase from 9.0 to 10.7 deaths per 1000 births in the comparison hospitals (overall unadjusted reduction of 3.6 deaths per 1000 live births).(6)

Training in emergency obstetric care (EmOC)

An overview of systematic review by Ameh et al identified five relevant systematic reviews examining the effectiveness of training in Emergency Obstetric Care on neonatal and perinatal health outcomes.

Intervention included education interventions and skill building drills on junior doctors, senior doctors and midwives on Emergency Obstetric Care. There were five training packages. Training period varied between 1 day and 5 days. Duration of training ranged from two min for one EmOC component to 24 weeks of additional training for comprehensive EmOC. (26)

Two before and after study reported a significant reduction in neonatal deaths [RR 0.53, (0.43-0.65; $p \leq 0.0001$)] and 7-day neonatal mortality rate decreased from 11.5% to 6.8% deaths per 1,000 live births after training [RR 0.95 (0.48 to 0.77; $p < 0.001$)]. Another before and after study reported reduction in immediate neonatal mortality - 6 deaths before, 0 deaths after the intervention, $p = 0.003$.(26)

Community mobilization

An overview of systematic review by Questa et al was included in this review which identified health system intervention pertaining to implementation strategies. One systematic review was identified from the umbrella which examined the effectiveness of community engagement interventions on child and maternal health outcomes. (10)

Intervention was women's groups practicing a participatory learning and action approach focused on child and maternal health. The techniques included 'sensitisation' with the community, (e.g. raising awareness of a health intervention with the community before the intervention begins, allowing opportunity for engagement), as well as community members becoming directly involved in the delivery or organisation of health services. The study reported significant 20% reduction in neonatal mortality on meta-analysis. (10)

Outreach services, community mobilization

A systematic review (critically low confidence in result of SR) by Houweling et al (2019) was classified under multi domain category. The SR included four randomised

controlled trials conducted in India, Nepal, Bangladesh and Malawi, focussed on outreach services and community mobilization. The systematic review examined the effect of community-based women's groups on neonatal mortality in lower and higher socioeconomic strata and tested for differences in effect between strata.

In the intervention group participatory learning and action groups were set up. The groups identified and prioritized maternal and newborn health problems and developed and evaluated strategies to address them. Strategies included, among others, home visits to pregnant women, emergency funds, arrangements for emergency transport to a health facility, and the preparation and distribution of safe delivery kits. The groups met monthly under the guidance of a facilitator for 2–3 years. The women's groups, for example, organized community meetings in which they explicitly asked support from the wider community for implementation of their strategies.

Results from meta-analysis reported that the intervention reduced NMR substantially and equitably across lower and higher socioeconomic groups [OR 0.51 (0.42–0.63; P-value 0.000)] (Pooled estimate for all), most marginalized- 63% mortality reduction [OR 0.37 (0.26–0.52)] and less marginalized-35% mortality reduction, [OR 0.65, (0.50–0.85; p-value for difference= 0.009)]. Those who were illiterate, and poor categorized as 'most marginalized' and the rest of the population as 'less marginalized'.

The early NMR was also reduced significantly across the groups [OR 0.47 (0.37–0.61) P-value 0.000]]. Early NMR reduced in most marginalized [OR 0.39 (0.26–0.59)] and less marginalized group [OR 0.56 (0.41–0.77; P-value 0.171)]. Late NMR was also reduced significantly [OR 0.58 (0.40–0.84; P-value 0.0040)] Late NMR reduced in most marginalized [OR 0.28 (0.15–0.52)] and less marginalized groups respectively [OR 0.93 (0.58–1.49; P-value 0.003)].

Multifaceted Continuous quality improvement

A systematic review by Rohwer et al (2020) (high confidence in result of SR) assessed the relative benefits and risks of multifaceted strategies including educational interventions which aim to optimise the use of antenatal corticosteroids (ACS) for anticipated preterm birth. The SR identified one cluster RCT (ACT trial) carried out in Argentina, Zambia, Guatemala, India), Pakistan and Kenya on 100705 women giving birth at 34 weeks' gestational age. (9)

The trial compared multifaceted strategies aiming to promote the use of antenatal corticosteroids. The strategies consist of- Provision of antenatal corticosteroid kits (ready-to-use boxes containing corticosteroid vials, syringes, gloves, instructions for administration;

Components to improve identification and referral of women at high risk of preterm labour (posters as reminders in areas of care, pregnancy discs to estimate date of

delivery if LMP is known, uterine height tape for identification of women at high risk of preterm birth); and

Components to improve the administration of antenatal corticosteroids to eligible women by training birth attendants, to identify women eligible for antenatal corticosteroids, appropriately use the preterm kit, refer the women to a health centre or contact skilled birth attendant when necessary.

Increased risk of perinatal death [RR 1.11 (1.04 to 1.19; Moderate quality evidence)] and neonatal death before 28 days at population level was reported [RR 1.12 (1.02 to 1.23; moderate quality evidence)].(9)

Clinical Practice Guidelines to improve quality of care

Another high confidence in result of systematic review by Tolu et al identified five RCTs involving 293467 labouring mothers and newborns. The SR examined the effectiveness of utilizing the WHO safe childbirth checklist on improving essential childbirth practices, early neonatal death, stillbirth, maternal mortality, and morbidity. The intervention assessed was a 29-item evidence-based WHO Safe Birth Checklist on essential childbirth practices to help health-care workers to deliver consistently high quality maternal and perinatal care. (8)

No statistically significant difference in early neonatal death with or without WHO SCC utilization [OR 1.07 (90.01 to 1.13; 5 studies; very low quality of evidence on GRADE)] was reported. (8)

Audit and feedback, Clinical incident reporting to improve quality of care

One systematic review of low confidence in result examined the effectiveness of the maternal near-miss case review on quality of care and maternal and perinatal health outcomes in low-income and middle-income countries. The SR included five studies conducted in African countries and Malaysia, four of which could be included in meta-analysis.(28)

The intervention examined was the maternal near-miss cases review (NMCR) approach. The facility-based individual NMCR cycle is defined as a type criterion-based audit seeking to improve maternal and perinatal healthcare and outcomes by conducting a review, at hospital level, of the care provided to maternal near-miss cases. Audits were conducted in phases by facility staff, district teams and non-medical assistants. The audits ranged between weeks to months and were carried out both prospectively and retrospectively.

Meta-analysis result reported no significant differences in perinatal deaths in the before and after period [OR 0.92 (0.65 to 1.30 ;4 studies)]. Another study reported a significant reduction in the incidence of a combined outcome including perinatal severe morbidities, deaths and stillbirths.(28)

Governance Arrangements

We did not find any systematic reviews on effectiveness of governance interventions in reducing NMR.

Financial Arrangements

We did not find any systematic reviews on effectiveness of financing interventions in reducing NMR

Confidence in results of included SRs

We used AMSTAR-2 for assessing the confidence in results of included SRs and found that of the included 22 systematic reviews most of the SRs (eleven) were rated critically low. (7, 11, 13, 16-18, 20, 21, 23-25). This implies the SRs had more than one critical flaw and should not be relied on to provide an accurate and comprehensive summary of the available studies on the topic. There were five SRs each which were rated high in overall confidence(1, 6, 8, 9, 12) and low confidence (14, 15, 19, 27, 28) in the results respectively. Only one SR was rated moderate.(22) No quality appraisal was conducted for two overviews of SRs.(10, 26)

4. References

1. Lassi ZS, Kedzior SG, Bhutta ZA. Community-based maternal and newborn educational care packages for improving neonatal health and survival in low- and middle-income countries. *Cochrane Database Syst Rev.* 2019;2019(11).
2. Simon JL DB, Boschi-Pinto C, Aboubaker S, Were W. Child health guidelines in the era of sustainable development goals. *The BMJ.* 2018.
3. Hanson C, Kujala S, Waiswa P, Marchant T, Schellenberg J. Community-based approaches for neonatal survival: meta-analyses of randomized trial data. *Bull World Health Organ.* 2017;95(6):453-64C.
4. Effective Practice and Organisation of Care E. The EPOC taxonomy of health systems interventions. EPOC Resources for review authors. Oslo: Norwegian Knowledge Centre for the Health Services. 2016.
5. Shea BJ RB, Wells G, Thuku M, Hamel C, Moran J, Moher D, Tugwell P., Welch V KE, Henry DA. . AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ.* 2017 Sep

- 21.
6. Willcox ML, Price J, Scott S, Nicholson BD, Stuart B, Roberts NW, et al. Death audits and reviews for reducing maternal, perinatal and child mortality. *Cochrane Database Syst Rev.* 2020;3(100909747):CD012982.
7. Versantvoort JMD, Kleinhout MY, Ockhuijsen HDL, Bloemenkamp K, de Vries WB, van den Hoogen A. Helping Babies Breathe and its effects on intrapartum-related stillbirths and neonatal mortality in low-resource settings: a systematic review. *Arch Dis Child.* 2020;105(2):127-33.
8. Tolu LB, Jeldu WG, Feyissa GT. Effectiveness of utilizing the WHO safe childbirth checklist on improving essential childbirth practices and maternal and perinatal outcome: A systematic review and meta-analysis. *PLoS ONE.* 2020;15(6):e0234320.
9. Rohwer AC, Oladapo OT, Hofmeyr GJ. Strategies for optimising antenatal corticosteroid administration for women with anticipated preterm birth. *Cochrane Database Syst Rev.* 2020;5(100909747):CD013633.
10. Questa K, Das M, King R, Everitt M, Rassi C, Cartwright C, et al. Community engagement interventions for communicable disease control in low- and lower- middle-income countries: evidence from a review of systematic reviews. *Intern j equity health.* 2020;19(1):51.
11. Peven K, Bick D, Pursell E, Rotevatn TA, Nielsen JH, Taylor C. Evaluating implementation strategies for essential newborn care interventions in low-and low middle-income countries: a systematic review. *Health Policy Plan.* 2020;35(Supplement_2):ii47-ii65.
12. Palmer MJ, Henschke N, Bergman H, Villanueva G, Maayan N, Tamrat T, et al. Targeted client communication via mobile devices for improving maternal, neonatal, and child health. *Cochrane Database Syst Rev.* 2020;8(100909747):CD013679.
13. Morris SM, Fratt EM, Rodriguez J, Ruman A, Wibecan L, Nelson BD. Implementation of the Helping Babies Breathe Training Program: A Systematic Review. *Pediatrics.* 2020;146(3).
14. van Veenendaal NR, Heideman WH, Limpens J, van der Lee JH, van Goudoever JB, van Kempen AAMW, et al. Hospitalising preterm infants in single family rooms versus open bay units: a systematic review and meta-analysis. *Lancet Child Adolesc Health.* 2019;3(3):147-57.
15. Tiruneh GT, Shiferaw CB, Worku A. Effectiveness and cost-effectiveness of home-based postpartum care on neonatal mortality and exclusive breastfeeding practice in low-and-middle-income countries: a systematic review and meta-analysis. *BMC Pregnancy Childbirth.* 2019;19(1):507.
16. Ricchi A, Rossi F, Borgognoni P, Bassi MC, Artioli G, Foa C, et al. The midwifery-led care model: a continuity of care model in the birth path. *Acta Biomed Ateneo Parmense.* 2019;90(6):41-52.
17. Niedzwiecka T, Patton D, Walsh S, Moore Z, O'Connor T, Nugent L. What are the effects of care bundles on the incidence of ventilator-associated pneumonia in paediatric and neonatal intensive care units? A systematic review. *J Spec Pediatr Nurs.* 2019;24(4):e12264.
18. Mbuthia F, Reid M, Fichardt A. mHealth communication to strengthen postnatal care in rural areas: a systematic review. *BMC Pregnancy Childbirth.* 2019;19(1):406.
19. Magwood O, Kpade V, Thavorn K, Oliver S, Mayhew AD, Pottie K. Effectiveness of home-based records on maternal, newborn and child health outcomes: A systematic review and meta-analysis. *PLoS ONE.* 2019;14(1):e0209278.
20. Hutton EK, Reitsma A, Simioni J, Brunton G, Kaufman K. Perinatal or neonatal mortality among women who intend at the onset of labour to give birth at home compared to women of low obstetrical risk who intend to give birth in hospital: A systematic review and meta-analyses. *EClinicalMedicine.* 2019;14:59-70.
21. Houweling TAJ, Looman CWN, Azad K, Das S, King C, Kuddus A, et al. The equity impact of community women's groups to reduce neonatal mortality: a meta-analysis of four cluster randomized trials. *Int J Epidemiol.* 2019;48(1):168-82.

22. DUBY J, LASSI ZS, BHUTTA ZA. Community-based antibiotic delivery for possible serious bacterial infections in neonates in low- and middle-income countries. *Cochrane Database Syst Rev.* 2019;4(100909747):CD007646.
23. Dol J, Richardson B, Tomblin Murphy G, Aston M, McMillan D, Campbell-Yeo M. Impact of mobile health (mHealth) interventions during the perinatal period for mothers in low- and middle-income countries: a systematic review. *JBI Database System Rev Implement Rep.* 2019;17(8):1634-67.
24. Doig M, Dizon J, Guerrero K, Parange N. Ao - Doig M, <http://orcid.org> O. Exploring the availability and impact of antenatal point-of-care ultrasound services in rural and remote communities: A scoping review. *Australasian J Ultrasound Med.* 2019;22(3):174-85.
25. Bekele BB, Dadi TL, Tesfaye T. The significant association between maternity waiting homes utilization and perinatal mortality in Africa: systematic review and meta-analysis. *BMC Res Notes.* 2019;12(1):13.
26. Ameh CA, Mdegela M, White S, van den Broek N. The effectiveness of training in emergency obstetric care: a systematic literature review. *Health Policy Plan.* 2019;34(4):257-70.
27. Wondemagegn AT, Alebel A, Tesema C, Abie W. The effect of antenatal care follow-up on neonatal health outcomes: A systematic review and meta-analysis. *Public Health Rev.* 2018;39(1):110.
28. Lazzarini M, Richardson S, Ciardelli V, Erenbourg A. Effectiveness of the facility-based maternal near-miss case reviews in improving maternal and newborn quality of care in low-income and middle-income countries: a systematic review. *BMJ Open.* 2018;8(4):e019787.

5. Appendices

Appendix 1: Search strategies

PubMed

No	Search Strategy	Hits
1	(Infant, Newborn [MeSH])	613230
2	newborn [tiab] OR neonat* [tiab]	814266
3	Meta-Analysis [Mesh]	122281
4	"Systematic Review" [MeSH]	137686
5	systematic review" or meta-analysis [tiab]	309175
6	3 OR 4 OR 5 OR 6	235364
7	1 OR 2	816897
8	7 OR 8	8879
9	8 AND [English]lim [2017- current]	2925

EMBASE

No	Search Strategy	Hits
1	("Infant, Newborn"/de)	536317
2	newborn [tiab] OR neonat* [tiab]	763914
3	("Meta-Analysis"/de)	202063

4	("Systematic Review*") OR ("meta-analysis*"): ti	240936
5	("systematic review*") OR ("meta-analysis*"): ab	260473
6	3 OR 4 OR 5 OR 6	448632
7	1 OR 2	763914
8	7 OR 8	10043
9	8 AND [English]lim [2017- current]	4066
10	9 AND [exclude medline journal]	435

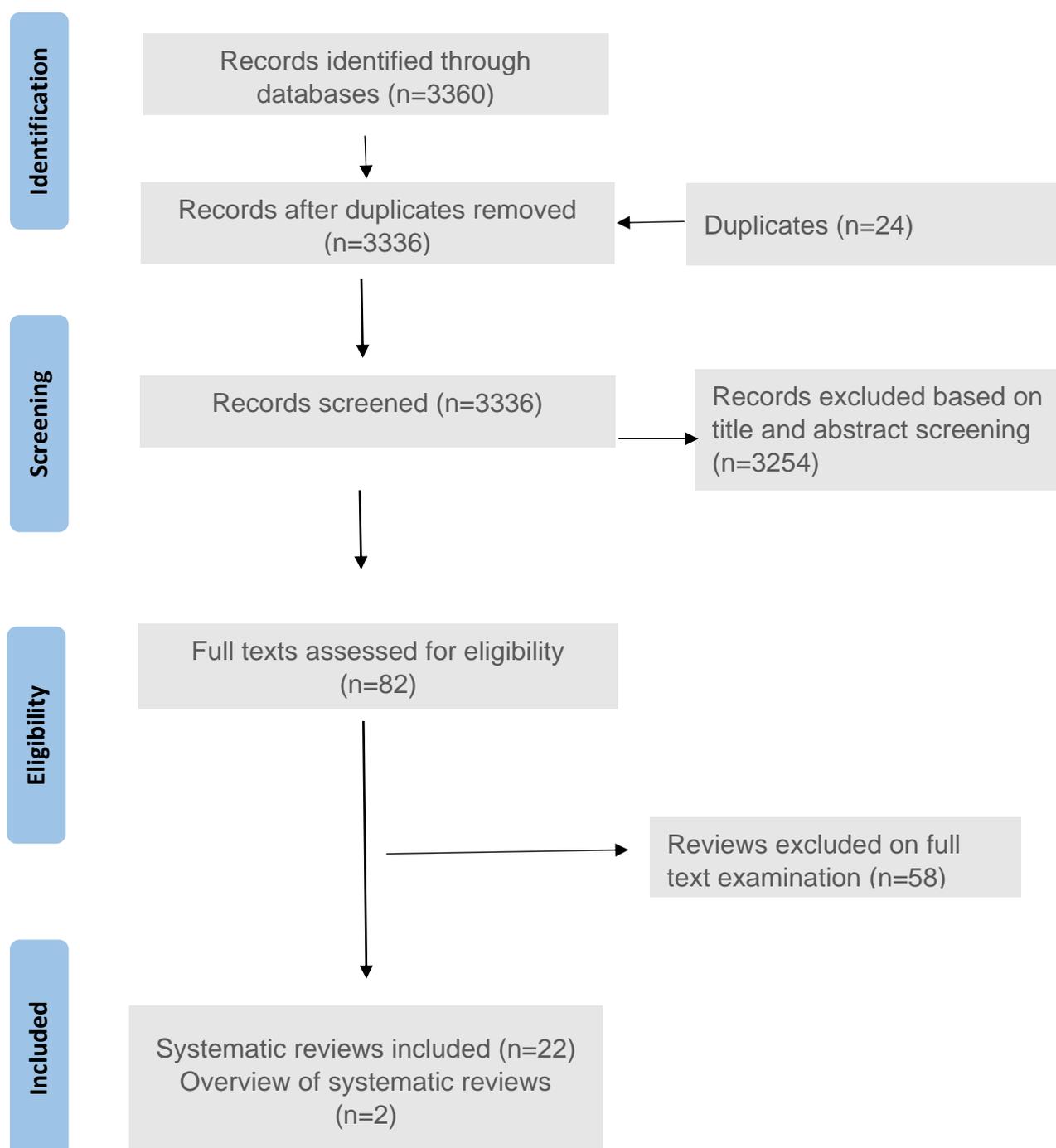
Appendix 2: Minimal list of health systems interventions and different aspects of neonatal care

Health Systems Intervention Category	Different aspects of neonatal care
Delivery strategies	<ul style="list-style-type: none"> • Skilled birth attendance in community deliveries • Emergency obstetric care (EmOC) services • Community or home-based neonatal care • Facility based new-born care and resuscitation (example New-born Stabilization Unit (NBSU) at block level; Special New-born Care Unit (SNCU) at district level; New-born Intensive Care Unit (NICU) at regional level) • Presumptive antibiotic therapy for the new-borns with high risk of bacterial infection
Implementation strategies	<ul style="list-style-type: none"> • Essential new-born care (immediate and thorough drying, immediate skin to skin or Kangaroo Mother care, cord care and delayed cord clamping and early initiation and exclusive breastfeeding) • Active management of third stage of labour, management of postpartum haemorrhage, induction of labour for prolonged pregnancy • Identification of complications in pregnant woman and timely referral with or without pre-referral dose of ante-natal corticosteroids and/or antibiotics for preterm labour and Premature Rupture of Membranes • Prophylactic antibiotic for caesarean-section • Management of postpartum haemorrhage, Induction of labour for prolonged pregnancy • Neonatal resuscitation with bag and mask • Case management of neonatal sepsis, meningitis and pneumonia and neonatal jaundice, small and pre-term babies • Presumptive antibiotic therapy for the new-borns with high risk of bacterial infection • Facility based new-born care and resuscitation (example New-born Stabilization Unit (NBSU) at block level; Special New-born Care Unit (SNCU)

	at district level; New-born Intensive Care Unit (NICU) at regional level)
--	---

Appendix 3 – PRISMA flow charts

FIGURE 1: PRISMA STUDY SELECTION FLOW CHART FOR SYSTEMATIC REVIEWS



Appendix 4: List of excluded studies

1. Neupane S, Doku DT. Association of the quality of antenatal care with neonatal mortality: meta-analysis of individual participant data from 60 low- and middle-income countries. *Int Health*. 2019;11(6):596-604. **Searched before 2017**
2. Ljungblad LW, Sandvik SO, Lyberg A. Ao - Ljungblad LW, Orcid: <http://orcid.org/---> Ao - Lyberg A, <http://orcid.org> O. The impact of skilled birth attendants trained on newborn resuscitation in Tanzania: A literature review. *Int J Afr Nurs Sci*. 2019;11:100168. **Searched before 2017**
3. Zaka N, Alexander EC, Manikam L, Norman ICF, Akhbari M, Moxon S, et al. Quality improvement initiatives for hospitalised small and sick newborns in low- and middle-income countries: a systematic review. *Implement Sci*. 2018;13(1):20. **Searched before 2017**
4. Phillippi JC, Danhausen K, Alliman J, Phillippi RD. Neonatal Outcomes in the Birth Center Setting: A Systematic Review. *J Midwifery Womens Health*. 2018;63(1):68-89. **Searched before 2017**
5. Yonemoto N, Dowswell T, Nagai S, Mori R. Schedules for home visits in the early postpartum period. *Cochrane Database Syst Rev*. 2017;8(100909747):CD009326. **Searched before 2017**
6. Solnes Miltenburg A, Roggeveen Y, van Roosmalen J, Smith H. Factors influencing implementation of interventions to promote birth preparedness and complication readiness. *BMC Pregnancy Childbirth*. 2017;17(1):270. **Searched before 2017**
7. Patel A, Khatib MN, Kurhe K, Bhargava S, Bang A. Impact of neonatal resuscitation trainings on neonatal and perinatal mortality: A systematic review and meta-analysis. *BMJ Paediatr Open*. 2017;1(1):Y. **Searched before 2017**
8. Pantoja T, Opiyo N, Lewin S, Paulsen E, Ciapponi A, Wiysonge CS, et al. Implementation strategies for health systems in low-income countries: an overview of systematic reviews. *Cochrane Database Syst Rev*. 2017;9(100909747):CD011086. **Searched before 2017**
9. Nkonki L, Tugendhaft A, Hofman K. A systematic review of economic evaluations of CHW interventions aimed at improving child health outcomes. *Hum Resour Health*. 2017;15(1):19. **Searched before 2017**
10. Melton KR, Ni Y, Tubbs-Cooley HL, Walsh KE. Using Health Information Technology to Improve Safety in Neonatal Care: A Systematic Review of the Literature. *Clin Perinatol*. 2017;44(3):583-616. **Searched before 2017**
11. Imamura M, Kanguru L, Penfold S, Stokes T, Camosso-Stefinovic J, Shaw B, et al. A systematic review of implementation strategies to deliver guidelines on obstetric care practice in low- and middle-income countries. *Int J Gynaecol Obstet*. 2017;136(1):19-28. **Searched before 2017**

12. Hunter BM, Murray SF. Demand-side financing for maternal and newborn health: what do we know about factors that affect implementation of cash transfers and voucher programmes? *BMC Pregnancy Childbirth*. 2017;17(1):262. **Searched before 2017**
13. Hunter BM, Harrison S, Portela A, Bick D. The effects of cash transfers and vouchers on the use and quality of maternity care services: A systematic review. *PLoS ONE*. 2017;12(3):e0173068. **Searched before 2017**
14. Hanson C, Kujala S, Waiswa P, Marchant T, Schellenberg J. Community-based approaches for neonatal survival: meta-analyses of randomized trial data. *Bull World Health Organ*. 2017;95(6):453-64C. **Searched before 2017**
15. Ciapponi A, Lewin S, Herrera CA, Opiyo N, Pantoja T, Paulsen E, et al. Delivery arrangements for health systems in low-income countries: an overview of systematic reviews. *Cochrane Database Syst Rev*. 2017;9(100909747):CD011083. **Searched before 2017**
16. Benahmed N, San Miguel L, Devos C, Fairon N, Christiaens W. Vaginal delivery: how does early hospital discharge affect mother and child outcomes? A systematic literature review. *BMC Pregnancy Childbirth*. 2017;17(1):289. **Searched before 2017**
17. Bastos ML, Menzies D, Hone T, Dehghani K, Trajman A. The impact of the Brazilian family health strategy on selected primary care sensitive conditions: A systematic review. *PLoS ONE*. 2017;12(8):e0182336. **Searched before 2017**
18. Aleman A, Tomasso G, Cafferata ML, Colomar M, Betran AP. Supply kits for antenatal and childbirth care: a systematic review. *Reprod Health*. 2017;14(1):175. **Searched before 2017**
19. Anton O, Jordan H, Rabe H. Strategies for implementing placental transfusion at birth: A systematic review. *Birth*. 2019;46(3):411-27. - **Wrong outcome- placental transfusion at birth and studies on barriers to implementation**
20. Araujo da Silva AR, Albernaz de Almeida Dias DC, Marques AF, Biscaia di Biase C, Murni IK, Dramowski A, et al. Role of antimicrobial stewardship programmes in children: a systematic review. *J Hosp Infect*. 2018;99(2):117-23.- **Wrong outcome reported- reduction in antibiotic consumption, reduction in broadspectrum/restricted antibiotic use,bacterial resistance etc.**
21. Araujo da Silva AR, Marques A, Di Biase C, Faitanin M, Murni I, Dramowski A, et al. Effectiveness of antimicrobial stewardship programmes in neonatology: a systematic review. *Arch Dis Child*. 2020;105(6):563-8.- **Wrong outcome - reduction of antibiotic consumption overall and of broad- spectrum/ target antibiotics, inappropriate antibiotic use, antibiotic resistance and HAIs.**
22. Ben Charif A, Zomahoun HTV, LeBlanc A, Langlois L, Wolfenden L, Yoong SL, et al. Effective strategies for scaling up evidence-based practices in primary care: a systematic review. *Implement Sci*. 2017;12(1):139.- **Wrong population/intervention not relevant- any individual, organization, or system involved in the delivery or receipt of primary health services;**
23. Budhathoki SS, Gurung R, Ewald U, Thapa J, Kc A. Does the Helping Babies Breathe Programme impact on neonatal resuscitation care practices? Results from systematic review and

meta-analysis. *Acta Paediatr.* 2019;108(5):806-13.- **Wrong outcome reported- changes in the use of stimulation, suctioning and bag-and-mask ventilation**

24. Chan G, Bergelson I, Smith ER, Skotnes T, Wall S. Barriers and enablers of kangaroo mother care implementation from a health systems perspective: a systematic review. *Health Policy Plan.* 2017;32(10):1466-75.- **Wrong outcome reported- barriers and enablers to KMC adoption**

25. Chu L, Qiao J, Xu C. Home-Based Phototherapy Versus Hospital-Based Phototherapy for Treatment of Neonatal Hyperbilirubinemia: A Systematic Review and Meta-Analysis. *Clin Pediatr (Phila).* 2020;59(6):588-95.- **Wrong outcome- Rate of total serum bilirubin decrease, duration of therapy**

26. Davidson JE, Aslakson RA, Long AC, Puntillo KA, Kross EK, Hart J, et al. Guidelines for Family-Centered Care in the Neonatal, Pediatric, and Adult ICU. *Crit Care Med.* 2017;45(1):103-28.- **Wrong outcome- reports guidelines**

27. Dawes L, Groom K, Jordan V, Waugh J. The use of specialised preterm birth clinics for women at high risk of spontaneous preterm birth: a systematic review. *BMC Pregnancy Childbirth.* 2020;20(1):58.- **Wrong outcome- Eligibility criteria for referral, Types of investigations offered, Timing of planned first and last clinic visit, Frequency of planned clinic review etc.**

28. Ding X, Zhu L, Zhang R, Wang L, Wang T-T, Latour JM. Effects of family-centred care interventions on preterm infants and parents in neonatal intensive care units: A systematic review and meta-analysis of randomised controlled trials. *Aust Crit Care.* 2019;32(1):63-75.- **Wrong outcome- Hospital readmission rate, length of stay, Nosocomial infection rate, morbidity etc.**

29. Dol J, Delahunty-Pike A, Anwar Siani S, Campbell-Yeo M. eHealth interventions for parents in neonatal intensive care units: a systematic review. *JBIC Database System Rev Implement Rep.* 2017;15(12):2981-3005.- **Wrong outcome of interest- parent-related outcomes, neonatal outcomes (length of stay, postmenstrual age at discharge, parental presence and visits).**

30. Fallon VM, Harrold JA, Chisholm A. The impact of the UK Baby Friendly Initiative on maternal and infant health outcomes: A mixed-methods systematic review. *Matern Child Nutr.* 2019;15(3):e12778.- **Wrong outcome- breastfeeding outcomes**

31. Feyissa GT, Balabanova D, Woldie M. How effective are mentoring programs for improving health worker competence and institutional performance in africa? A systematic review of quantitative evidence. *J MultidiscipHealthc.* 2019;12:989-1005.- **Wrong outcome reported- competence (knowledge and skills, adherence to standard protocols);**

32. Fry TJ, Marfurt S, Wengier S. Systematic Review of Quality Improvement Initiatives Related to Cue-Based Feeding in Preterm Infants. *Nurs Womens Health.* 2018;22(5):401-10.- **Wrong study outcome- weight gain, NICU length of stay, and attainment of full oral feedings;**

33. Gavine A, MacGillivray S, McConville F, Gandhi M, Renfrew MJ. Pre-service and in-service education and training for maternal and newborn care providers in low- and middle-income countries: An evidence review and gap analysis. *Midwifery.* 2019;78(8510930):104-13.- **Wrong outcome-knowledge and/or skills;**

34. Geremew AB, Boke MM, Yismaw AE. The Effect of Antenatal Care Service Utilization on Postnatal Care Service Utilization: A Systematic Review and Meta-analysis Study. *J Pregnancy*. 2020;2020(101553823):7363242.- **Wrong population**
35. Hamline MY, Speier RL, Vu PD, Tancredi D, Broman AR, Rasmussen LN, et al. Hospital-to-Home Interventions, Use, and Satisfaction: A Meta-analysis. *Pediatrics*. 2018;142(5).- **Wrong outcome- no newborn mortality outcome reported**
36. Herrera CA, Lewin S, Paulsen E, Ciapponi A, Opiyo N, Pantoja T, et al. Governance arrangements for health systems in low-income countries: an overview of systematic reviews. *Cochrane Database Syst Rev*. 2017;9(100909747):CD011085.- **Wrong outcome- Not related to neonates**
37. Howard-Grabman L, Miltenburg AS, Marston C, Portela A. Factors affecting effective community participation in maternal and newborn health programme planning, implementation and quality of care interventions. *BMC Pregnancy Childbirth*. 2017;17(1):268.- **Wrong outcome-reports factor and facilitators of community participation;**
38. Huang J, Tang Y, Tang J, Shi J, Wang H, Xiong T, et al. Educational efficacy of high-fidelity simulation in neonatal resuscitation training: a systematic review and meta-analysis. *BMC Med Educ*. 2019;19(1):323.- **Wrong outcome- individual or team resuscitation performance (e.g., knowledge, skill and confidence);**
39. Jennings MC, Pradhan S, Schleiff M, Sacks E, Freeman PA, Gupta S, et al. Comprehensive review of the evidence regarding the effectiveness of community-based primary health care in improving maternal, neonatal and child health: 2. maternal health findings. *J glob health*. 2017;7(1):010902.- **Wrong outcome- Maternal outcomes reported**
40. Jones E, Lattof SR, Coast E. Interventions to provide culturally-appropriate maternity care services: factors affecting implementation. *BMC Pregnancy Childbirth*. 2017;17(1):267.- **Wrong outcome- reports facilitators and barriers to implementation of intervention;**
41. Jordan P, Mpsa F, Ten Ham-Baloyi W, Bowers C. Implementation strategies for guidelines at ICUs: a systematic review. *Int J Health Care Qual Assur*. 2017;30(4):358-72.- **Wrong outcome reported- Timing of surfactant administration; admission temperature, Reduction of nosocomial infection etc.**
42. Kebaya LMN, Kiruja J, Maina M, Kimani S, Kerubo C, McArthur A, et al. Basic newborn resuscitation guidelines for healthcare providers in Maragua District Hospital: a best practice implementation project. *JBHI Database System Rev Implement Rep*. 2018;16(7):1564-81.- **Wrong outcome- knowledge and skills;**
43. Kim SK, Park S, Oh J, Kim J, Ahn S. Interventions promoting exclusive breastfeeding up to six months after birth: A systematic review and meta-analysis of randomized controlled trials. *Int J Nurs Stud*. 2018;80:94-105.- **Wrong outcome- reports EBF rates**
44. Kourtis SA, Burns JP. Quality improvement in pediatric intensive care: A systematic review of the literature. *Pediatr Invest*. 2019;3(2):110-6.- **Wrong outcome- excluded studies that**

examined quality improvement processes exclusively for neonatal or adult patients receiving intensive care.

45. Lambert V, Matthews A, MacDonell R, Fitzsimons J. Paediatric early warning systems for detecting and responding to clinical deterioration in children: a systematic review. *BMJ Open*. 2017;7(3):e014497.- **Wrong outcome- No neonatal outcome reported**

46. Lazzerini, M, Ciuch. M, Rusconi, Silvia C, Benedetta Facilitators and barriers to the effective implementation of the individual maternal near-miss case reviews in low/middle-income countries: a systematic review of qualitative studies. *BMJ open*. 2018;8(6)- **Wrong outcome- reports facilitator and barriers**

47. Liu N, Li P, Wang J, Chen D, Sun W, Zhang W. Effects of home visits for pregnant and postpartum women on premature birth, low birth weight and rapid repeat birth: a meta-analysis and systematic review of randomized controlled trials. *Fam Pract*. 2019;36(5):533-43.- **Wrong outcome- premature birth (PTB), low birth weight (LBW) and rapid repeat birth (RRB).**

48. McFadden A, Siebelt L, Marshall JL, Gavine A, Girard L-C, Symon A, et al. Counselling interventions to enable women to initiate and continue breastfeeding: a systematic review and meta-analysis. *Int Breastfeed J*. 2019;14(101251562):42.- **Wrong outcome- reports breastfeeding outcomes**

49. Nguyen MNR, Mosel C, Grzeskowiak L.E. Ao - Grzeskowiak LE, <http://orcid.org> O. Interventions to reduce medication errors in neonatal care: a systematic review. *Ther Adv Drug Saf*. 2018;9(2):123-55.- **Wrong outcome- reports medication related outcomes**

50. Olufunlayo TF, Roberts AA, MacArthur C, Thomas N, Odeyemi KA, Price M, et al. Improving exclusive breastfeeding in low and middle-income countries: A systematic review. *Matern Child Nutr*. 2019;15(3):e12788.- **Wrong outcome- reports EBF until 6 months**

51. Segers E, Ockhuijsen H, Baarendse P, van Eerden I, van den Hoogen A. The impact of family centred care interventions in a neonatal or paediatric intensive care unit on parents' satisfaction and length of stay: A systematic review. *Intensive Crit Care Nurs*. 2019;50:63-70.- **wrong outcome- reports parents' satisfaction, and length of stay**

52. Seward N, Neuman M, Colbourn T, Osrin D, Lewycka S, Azad K, et al. Effects of women's groups practising participatory learning and action on preventive and care-seeking behaviours to reduce neonatal mortality: A meta-analysis of cluster-randomised trials. *PLoS Med*. 2017;14(12):e1002467.- **Wrong population- participants were women aged 15–49 years;**

53. Shakya P, Kunieda MK, Koyama M, Rai SS, Miyaguchi M, Dhakal S, et al. Effectiveness of community-based peer support for mothers to improve their breastfeeding practices: A systematic review and meta-analysis. *PLoS ONE*. 2017;12(5):e0177434.- **Wrong outcome- reports exclusive breastfeeding.**

54. Sikorski C, Van Hees S, Lakhanpaul M, Benton L, Martin J, Costello A, et al. Could Postnatal Women's Groups Be Used to Improve Outcomes for Mothers and Children in High-Income Countries? A Systematic Review. *Matern Child Health J*. 2018;22(12):1698-712.-**Wrong outcome- No neonatal outcome reported**

55. Sinha B, Chowdhury R, Upadhyay RP, Taneja S, Martines J, Bahl R, et al. Integrated Interventions Delivered in Health Systems, Home, and Community Have the Highest Impact on Breastfeeding Outcomes in Low- and Middle-Income Countries. *J Nutr.* 2017;147(11):2179S-87S.- **wrong outcome- reports breastfeeding outcomes**
56. Smith ER, Bergelson I, Constantian S, Valsangkar B, Chan GJ. Barriers and enablers of health system adoption of kangaroo mother care: a systematic review of caregiver perspectives. *BMC Pediatr.* 2017;17(1):35.- **Wrong outcomes- reports barriers and enablers**
57. Soleimani F, Rostami FF, Nouri JM, Hatamizadeh N, Sajedi F, Norouzi M. Impacts of the design of a neonatal intensive care unit (single-family room care and open-ward care) on clinical and environmental outcomes. *Crescent J Med Biol Sci.* 2020;7(1):1-6.- **Wrong outcome- No neonatal clinical outcome**
58. Wells S, Tamir O, Gray J, Naidoo D, Bekhit M, Goldmann D. Are quality improvement collaboratives effective? A systematic review. *BMJ Qual Saf.* 2018;27(3):226-40.- **Wrong population- multidisciplinary healthcare teams**