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Interventions for Reducing Infant Mortality in Developing Countries

A Literature Review

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Abstract

Infant mortality is a global public health issue. According to WHO, over 4 million infant deaths were recorded in 2018. A significant number of these deaths are due to preventable causes.

The aim of this study was to synthesis different available research in interventions for reducing infant mortality in developing countries. The purpose was to provide information and methods that could be adopted by professionals in different health care settings to reduce infant mortality rates.

The study was conducted as a literature review and data was collected using two databases: Cinahl Plus full-text and Academic Search Elite. Overall, eleven articles were chosen, and results were analyzed using inductive content analysis method. The following four main categories were generated: medical factors, behavior changes, policies to minimize infant mortality and knowledge and skills.

The review demonstrated that implementing and sustaining several low-cost interventions at community levels helped reduce infant mortality rates. The results also indicated the need for further studies in reviewing and updating the pediatric curriculum.

Keywords (subjects):

Infant mortality, neonatal mortality, child death, interventions, developing countries.

Miscellaneous

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1 Introduction

Infant or neonatal mortality is defined as the number of deaths of children under one year of age. Infant mortality rate measures the number of deaths per thousand live births within a given population or region. A child is at the highest risk of dying within the first 28 days of life due to lack of quality care at birth or delayed treatment. The most common causes of neonatal deaths are cited as birth defects, infections, birth asphyxia and pre-term births. (Song, Theodoratou, Li, Liu, Chu, Black, Campbell, Rudan and Chan, 2016).

According to 2018 WHO statistics, there were 4.0 million infant deaths, of which 75% died within the first year of life (World Health Organisation, 2018). The UN Inter-agency Group for Child Mortality Estimation stated the figures at 5.4 million deaths, with 2.5 million in the first month of life, 1.6 million from 1-11 months and 1.3 million occurring between the age of 1-4 years. In 2017 the average infant mortality rate was 18 deaths per 1000 live births globally. The region with the highest infant mortality was Sub-Saharan Africa with an average of 76 deaths per 1000 live births which is a ratio of 1 in 13 while the region with the lowest infant mortality rate in the world was Australia and New Zealand, with a ratio of 1 in 263 infant deaths. (United Nations Inter-Agency Group for Child Mortality Estimation, 2018).

Although statistics from 1990s to 2017 show significant decline in both post-neonatal deaths and child mortality rates of children under five, future projections by the UN Inter-agency Group for Child Mortality Estimation Report of 2018, indicates that between 2018-2030 about 56 million children will die before their fifth birthday. Half of those deaths will be neonates. (UNIGCME, 2018.)

Infant mortality is a major public health issue globally as many statistics show that there is a significant number of infant deaths due to some preventable causes. Despite the major gains in technological advancement in the medical fields and availability of vaccines, the numbers are still alarmingly high. (Song et al. 2016.)

The aim of this study is to synthesis different available research in interventions for reducing infant mortality in developing countries. The purpose of the study is to provide information and methods that could be adopted by nurses in different health care settings to reduce infant mortality rates.

2 Infant Mortality

2.1 Epidemiology

An infant is defined as a child under the age of one year, while a neonate is a new-born child under 28 days of age. Infant mortality refers to the total number of deaths of children under one year of age. This is normally expressed in terms of the infant mortality rate, which measures the number of live births per thousand births within a given population. (UNIGME 2018.)

Infant mortality rates have shown a significant decline over the past two and a half decades, but the figures continue to be alarmingly high. Over 2.5 million neonates and 1.6 million infants died in the year 2017 globally. The risk of dying within the first 28 days of life was estimated to be around 18 deaths per 1,000 live births, representing a 41% decline. The chance of dying within the first year was estimated at 12 deaths per 1,000. This represents a 51% decline since the year 2000. According to WHO between 2000 and 2017, high income

countries recorded the lowest declines in infant mortality rates as these were already lower from the beginning of the '90s to year 2000. (UNIGME 2018). Figure 1 below shows the trends in infant mortality globally from 1990 to 2018, according to WHO statistics of 2018.

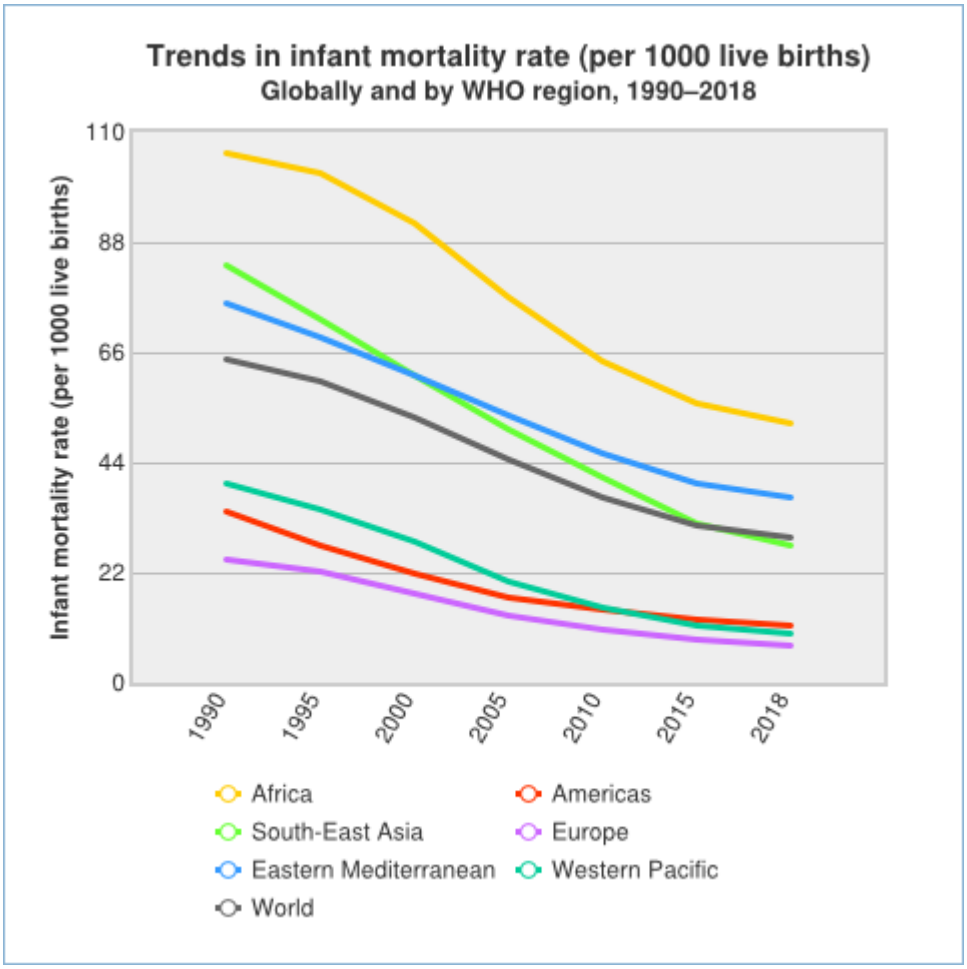

Figure 1. Trends in infant mortality. (Source WHO 2018)

According to UNIGME (2018), neonatal deaths in 2017 accounted for 2.5 million deaths with three quarters dying within the first week of being born. In the 1990s, neonatal mortality was between 36-38 deaths per thousand live births, while in in 2017 the figure had declined to an average of 18 deaths per 1,000 live births. The largest decline came from East Asia and Europe, while Sub-Saharan Africa and Southern Asia remained with the highest neonatal mortality with 27 and 26 deaths per 1,000 live births respectively. Figure 2

below shows the decline in under-five mortality rates in WHO regions between 1990 and 2017. (UNIGME, 2018.)

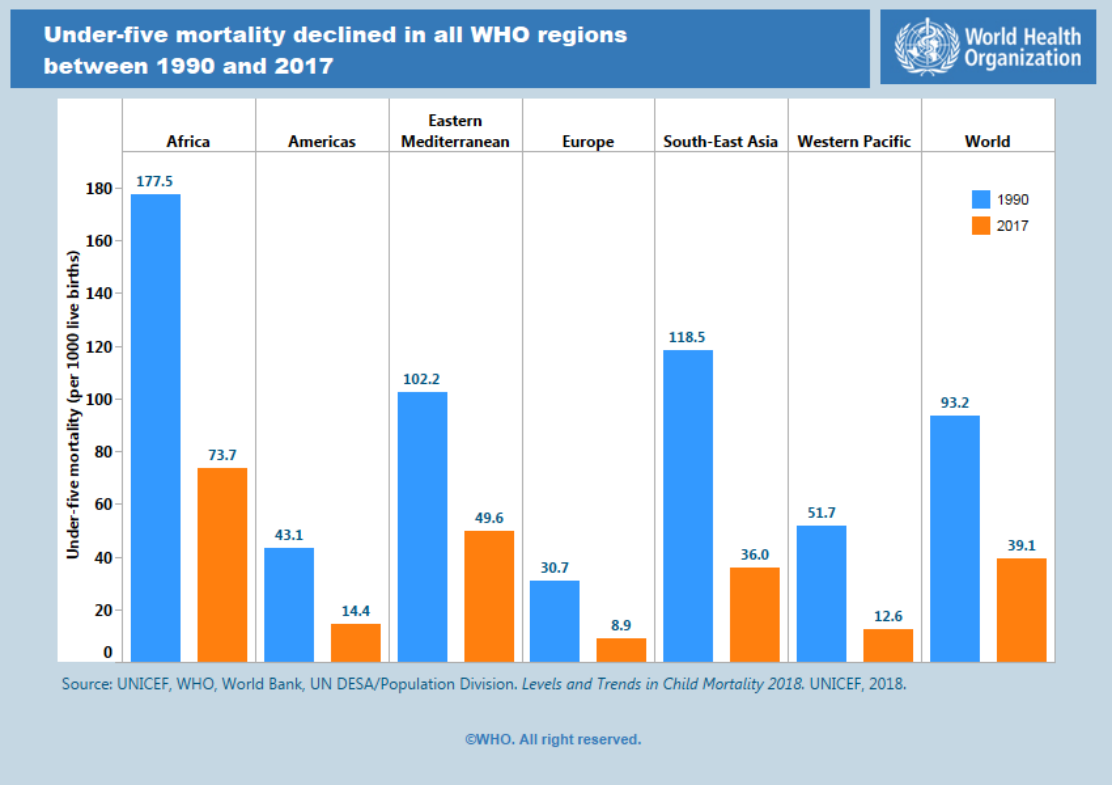

Figure 2. Decline in under-five mortality. (Source WHO 2018)

Some determining factors for survival seem to be linked to the region's economic status. According to the 2017 statistics, Sub-Saharan African countries have the highest infant mortality rates with an estimated 76 deaths per thousand live births. This means that 1 in every 13 children dies before they reach the age of 5. In comparison, in high- income countries 1 in every 185 children dies before their fifth birthday. This is a clear indication of how income disparities influence child survival rates worldwide. Six countries with the highest infant mortality rates and under 5 mortality rates came from Sub-Saharan Africa 50% of the deaths and Southern Asia, with 30%.

2.2 Causes of Infant Mortality

Preterm birth complications are the leading cause of infant deaths worldwide due to reduced quality of maternal or foetal nursing care. Preterm birth refers to any birth before completing 37 weeks of gestation and is classified into three groups: Extremely preterm- less than 28 weeks, very preterm- between 28 to 32 weeks, and moderate to late preterm- between 32-37 weeks. (WHO 2018).

Those occurring in the first weeks include breathing problems, heart problems, underdeveloped immune system leading to high risk of infections, metabolism problems like hypoglycemia, anemia, gastrointestinal problems, brain hemorrhage, hypothermia and jaundice. Some risk factors of premature delivery include multiple pregnancies, infections of the lower genital tract and amniotic fluid, problems of the uterus, cervix or placenta, smoking and using illicit drugs while pregnant, short interval between pregnancies and chronic conditions such as diabetes and high blood pressure. A history of multiple miscarriages, abortions and previous premature births could also lead to premature delivery. In addition, trauma, physical injuries or other stressful events for example death of a loved one could also trigger premature delivery. (WHO, 2018.)

Low birth weight (LBW), according to WHO (2018), is birth of an infant weighing less than 2500grams. It is mainly caused by premature birth and intrauterine growth restriction (IUGR). IUGR, also known as foetal growth restriction, is a slow prenatal growth rate which results in an infant being small for gestational age (SGA). SGA new-borns are those whose weight is below the 10^{th} percentile for the gestational age. Risk factors for LBW include teen

pregnancies, multiple pregnancies, chronic diseases, poor prenatal care, poor nutrition, smoking, drug abuse and alcohol abuse. (WHO, 2018).

Birth defects. WHO (2016), states that congenital disorders, malformations or anomalies are structural or functional anomalies that occur before or during birth. Most congenital anomalies are caused by genetic, environmental or socioeconomic factors. In middle- and low-income countries, pregnant women may lack good nutrition or proper healthcare access due to their limited resources. At the same time, they may also be exposed to infections, pesticides, chemicals and other factors such as alcohol and smoking. All these increase the chances of abnormal prenatal development. If parents are from the same kinship, consanguinity, the risk of genetic congenital anomalies is increased. (WHO, 2016)

Infections. Neonatal infections including sepsis, pneumonia, meningitis, tetanus and diarrhoea are the most common causes of neonatal deaths in developing countries. Viral infections include rubella, herpes simplex virus (HSV), varicella-zoster virus, hepatitis, parvovirus and HIV. Some of these infections are acquired through raptured membranes or in the birth canal during delivery(intrapartum) or postpartum. Several factors contribute to these infections and subsequent deaths: poor or no antenatal care, preterm deliveries, low birth weights, unhygienic and unsafe delivery practices and cord care, poor health infrastructure and resources, economic hardships and lack of exclusive breastfeeding. (Thaver & Zaidi 2009.)

Sudden infant death syndrome (SIDS). According to Bartlow, Cartwright and Shefferly (2016), SIDS, also known as cot or crib death is an unexpected and unexplained infant death in their sleep and occasionally while awake. Although the exact cause is unknown, it has been established that infant sleep positioning; mainly prone position and side-lying, and sleep environment,

that is, soft items in cribs are significant risk factors for SIDS. In addition, defects in the infant's part of brain that controls breathing and arousal from sleep, low birth weight, respiratory infection, overheating while asleep, sharing a bed and having excess materials in a crib are other factors believed to contribute to it. Nurses working in the new-born units are uniquely placed to, not only educate parents and caregivers about reducing the risks of SIDS but also to role model the care of infants to them. (Bartlow et. al 2016.)

Perinatal asphyxia. According to McGuire (2007), perinatal asphyxia is a major cause of death amongst infants. It may present as a lack of breathing just before, or during or immediately after post-natal birth. This can lead to a decrease or a complete lack of oxygen (hypoxia)to the brain tissue, resulting in cardiorespiratory or neurological problems. An Apgar score is used to assess and determine the level of function and consciousness within five minutes of birth. (McGuire 2007.)

Risk factors include Meconium Aspiration Syndrome, where a baby may breathe in meconium during the birth process, or due to placental abruption, congenital anomalies, birth trauma, narcotics, depression of the umbilical cord and congenital sepsis. McGuire (2007), emphasizes the importance of prompt resuscitation of neonates to minimize death and neurological damage. Mengesha & Sahle (2017), state that delays in swift referrals and a lack of skilled health professionals maybe the leading cause of deaths due to asphyxia in Sub-Saharan Africa.

2.3 Environmental and Socio-economic Factors

Environmental factors can be classified into two. Firstly, the socio-economic status of poverty which has an impact on the quality of health or nursing care received by an individual, lack of proper sanitation and safe drinking

water. According to UNIGME (2018), children born into impoverished families and communities are twice at a higher risk of death compared to those born into well off families. Rich parents have more capabilities to provide their families with better sanitation and access to good healthcare. Therefore, they have low incidences of infant mortality as they are in a better financial position to afford good healthcare services. (UNIGME 2018.)

On the other hand, those living in rural areas have higher rates of mortality compared to babies born in urban areas, especially in less economically developed countries, as they have less access to better healthcare facilities and good quality nursing care. The second environmental factor is the effects of industrialization which has led to an increase in air pollution, resulting in respiratory problems in infants. (Muttunga 2007.) Over the years, nursing has made a big contribution in research of health-related issues with regards to the environment. Through these researches, nurses have participated in advocacy and promotion of safe environments to improve the health of children. (Thompson and Keeling 2012.)

3 Aim, Purpose and Research Question

The aim of this study is to synthesis different available research on interventions for reducing infant mortality in developing countries. The purpose of the study is to provide information and methods that could be adopted by healthcare professionals in different health care settings to reduce infant mortality rates. The research question is: What are the interventions for reducing infant mortality in developing countries?

4 Methodology

4.1 Literature Review

Whittemore & Knafl (2005), state that a literature review is an integrative review which is used to synthesize past empirical or theoretical literature, which gives a broad insight of a certain healthcare problem. The reviews may be used to advance knowledge of evidence-based practice, nursing science and research as well as using them to make policy reviews. (Whittemore et.al 2005)

The authors choose a literature review because there are previous empirical studies available on the interventions to reduce infant mortality. Literature reviews summarize previous research studies and highlight any gaps in knowledge which can be used to carry out further research into the specific phenomenon. (Whittemore et.al 2005.)

Literature review involves firstly identifying a topic, problem or phenomenon in practice which presents gaps in knowledge, and formulating questions that can be used to provide solutions and insights into the phenomenon in

question. The research question serves as a guideline and makes the search more specific to the phenomenon or topic of the research. From the research topic, the aims and purpose of the research are formulated. (Rew 2010.)

The second step involves the search for literature. The researcher identifies the most relevant sources for their research by clearly stating the inclusion and exclusion criteria of the papers used. The terms used to search for articles and the online databases searched are stated. The next step involves searching and refining, whereby search terms are used to find materials from the selected search engines. Most relevant and recent articles are chosen while carefully documenting each search process and steps taken in the article selection process. After completing this process, the next step would be to read and analyze the material and select quality articles that adequately answer the research question. After evaluating, data extraction is carried out by deciding which findings can be used to show accurate results of the search. The next step is to evaluate the trustworthiness of the material gathered and then finally the literature review is written highlighting the findings and drawing conclusions. (Rew, 2010; Whittemore et al. 2005.)

4.2 Literature search

Literature for this review was collected from two databases, Cinahl Plus full-text and Academic Search Elite. A preliminary search on the interventions in minimizing infant mortality in developing countries was done using PICOS as illustrated in the table 1. below. The search key words that were used in the research were “infant mortality”, “neonatal mortality”, “child death” “interventions” and “developing countries” to help refine the articles and obtain quality articles relevant to the research.

Table 1. Inclusion Criteria.

P (**P**roblem or **P**atient or **P**opulation)	Developing countries
I (interest)	Interventions
CO (Context)	Infant Mortality OR Neonatal mortality OR child death
S (Study design	In English, Peer reviewed, Empirical, published from 2008

The following inclusion criteria was used: Boolean operators (AND, OR), full text for JAMK students, peer reviewed, English language, relevant to the study, answers research question and publications between 2008 and 2019. A total of 11 articles were chosen based on the search. Table 2 shows the selection process and a table of the reviewed articles is found in appendix 1.

Table 2. Selection process.

Data base	Scope search	Based on inclusion criteria	Relevant studies	Based on developing countries	Answers research question
Cinahl plus full text	1882	1422	300	12	6
Academic search elite	1879	1335	170	9	5

4.3 Data Analysis

According to Elo & Kyngäs (2008), content analysis is a method of describing and quantifying phenomena, allowing for the extraction of the essential or most important aspects of the data and making replicable and valid inferences with the aim of providing new insights and knowledge and a guide for practice. Content analysis may be used in an inductive or deductive way. Inductive method moves from specific to general and can be used when no previous studies about the phenomenon exist or when it's fragmented. (Elo & Kyngäs, 2008). Since the authors did not have previous knowledge, they chose an inductive content analysis method to conduct the data analysis for this research. They did this in three stages: open coding, creating categories and abstraction.

Open coding involved highlighting the main findings by giving headings to describe all aspects of the content. These codes were further clustered together to form categories that described the phenomenon more and increased understanding. The abstraction stage involved further synthesis of the categories and naming them using content-characteristic words (Elo & Kyngäs, 2008.) Figure 3 below illustrates an example of the data analysis process used by the authors.

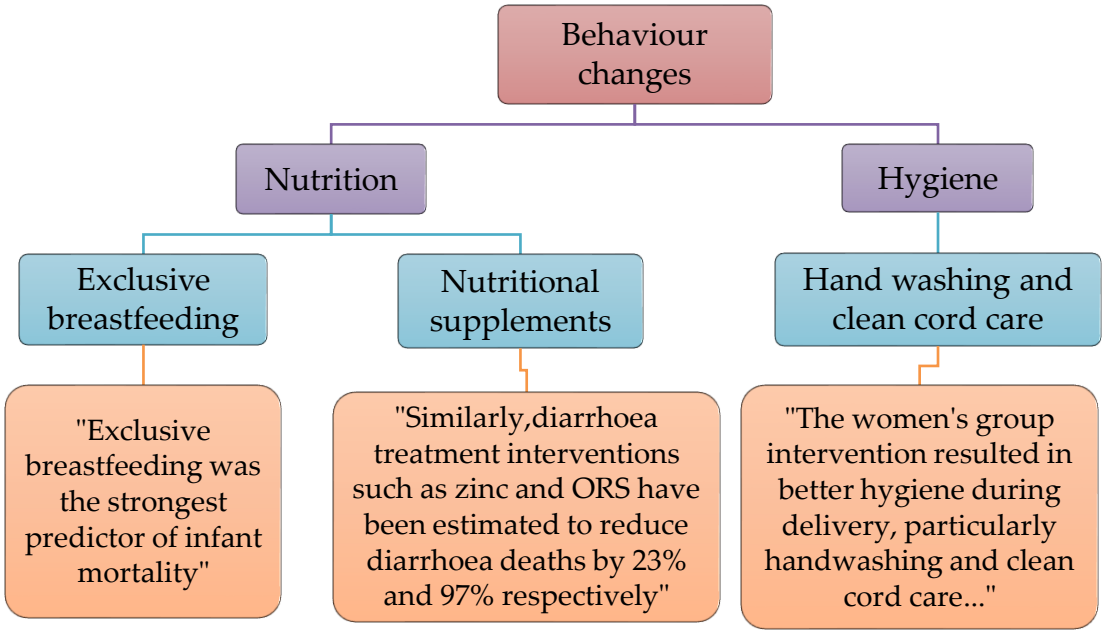

Figure 3. Data analysis process illustration.

5 Results

Findings from the analysis of the literature revealed four main categories of interventions for reducing infant mortality. These were: medical factors, behavior changes, policies to minimize infant mortality and knowledge and skills as, represented in figure 4 below.

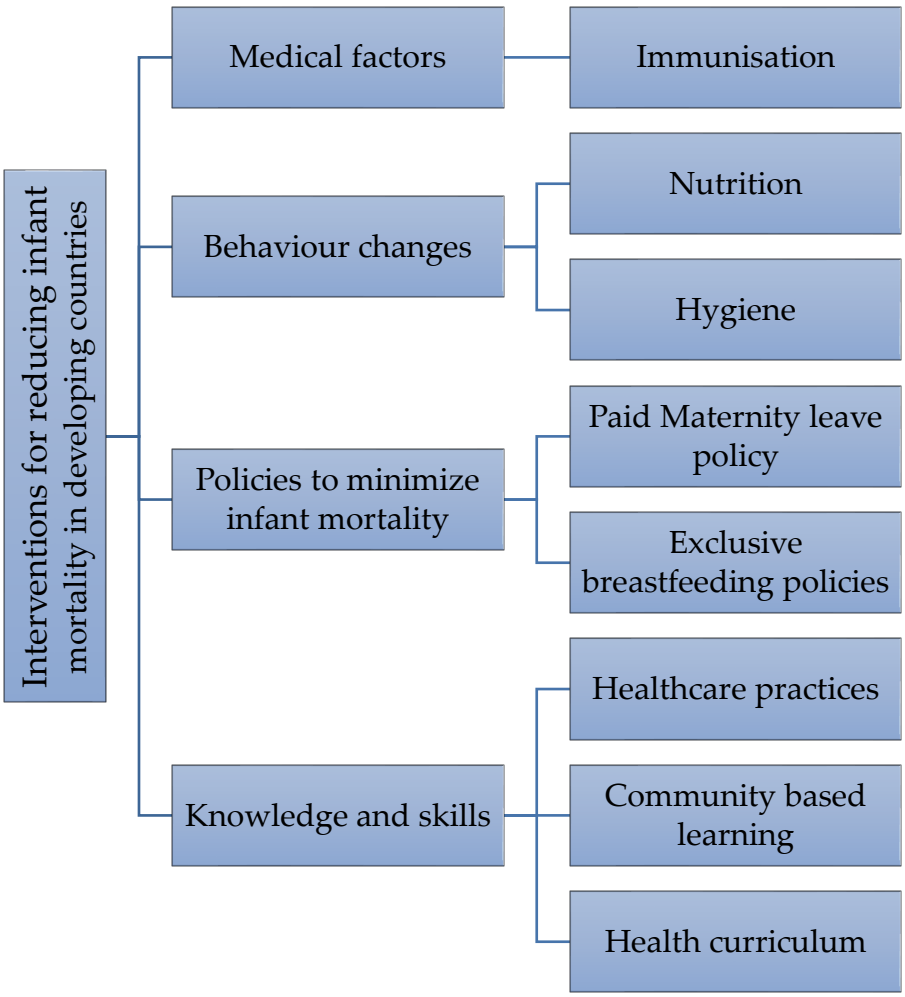

Figure 4. Themes and sub-themes of interventions for infant mortality.

5.1 Medical Factors

Immunization was a significant intervention in reducing infant mortality. Fewer infant deaths were reported in the vaccine period compared to the pre-vaccination period. The introduction of the 13-valent pneumococcal conjugate vaccine (PVC13), for example, led to reductions in hospitalizations and ambulatory visits for all-cause pneumonia. Consequently, there were reductions in pneumonia-related and bacterial meningitis deaths. These findings were

observed in several countries. (Becker-Dreps, Blette, Briceño, Alemán, Hudgens, Moreno, Ordonez, Rocha, Weber and Amaya 2017).

5.2 Behaviour changes

Nutrition and breastfeeding. Positive behavioural practices interventions, such as exclusive breastfeeding practices and providing adequate nutrition to infants, have been found to minimize infant mortality rates in developing countries. (Doherty, Rohde, Besada, Kerber, Manda, Loveday, Nsibande, Daviaud, Kinney, Zembe, Leon, Rudan, Degefie, Sanders, 2016; Biks, Berhane, Worku, & Gete, 2015). For example, a study conducted by Doherty et al. (2016), showed that infant mortality rates declined as a result of interventions which included the successful initiation of exclusive breastfeeding and supplementary nutrition programmes, such as giving the infants vitamin A and encouraging the use of oral rehydration salts (ORS) in extreme cases of diarrhoea.

Hygienic practices. Furthermore, interventions administered by women such as clean water, sanitation and proper hygiene resulted in decreased infant mortality rates were lowered and improved chances of survival of infants. Handwashing with soap was found to be directly related to a drop in the number of diarrhoea induced deaths in infants. This reduction is also attributed to an increase in knowledge and use of oral rehydration salts coupled with minerals such as zinc. (Biks et al. 2015; Bosomprah, Beach, Beres, Newman, Kapasa, Rudd, Njobvu, Guffey, Hubbard, Foo, Bolton-Moore, Stringer and Chilengi, 2015; Doherty et al. 2016; Sarbani, Mahapatra, Rath, Bajpai, Singh, Rath, Nair, Tripathy, Gope, Sinha, Costello, Pagel & Prost 2013)). Lastly, Sarbani et al. (2013), found that home and hospital care interventions, such as clean code cutting by birth attendants, proper handwashing,

providing neonates with proper warmth and encouraging women to exclusively breast feed their child in the first 6 weeks of their life can help to decrease mortality rates, especially in countries with poor access to health services.

5.3 Policies to minimize infant mortality

Paid maternity leave policies. Policies centering on longer paid maternity leave for parents who have recently given birth, have shown a reduction in infant, neonatal and post-natal deaths. Nandi, Hajizadeh, Harper, Koski, Strumpf, & Heymann (2016) state that in their study of low and middle-income countries where this intervention was tested, an increase in paid leave saw a corresponding decline in the infant deaths risk ratios.

Exclusive breastfeeding policies. Exclusive breast feeding has been identified as one of the interventions in reducing infant mortality rates. Chale, Fenton & Kayange (2016), state that policies that focus on enforcing breastfeeding at the healthcare facilities amongst health workers were significant in infant mortality. Training health care workers on these policies and the benefits of breast milk compared to formula feeding was an essential step in imparting knowledge of the benefits of breastfeeding to mothers of infants. (Chale et al. 2016).

5.4 Knowledge and skills

Health care practices. Campaigns in the form of song and dance with themes on safe pregnancy and delivery practices helped increase and improve health knowledge and practices among mothers. As a result, decline in infant deaths was observed. (Boone, Eble, Elbourne, Frost, Jayanty, Lakshminarayana,

Mann, Mukherjee, Piaggio and Reddy, 2017). Training of traditional birth attendants about clean delivery practices such as cord-cutting and hand washing as well as the use of home delivery-kit is significant in reducing infant mortality. The evidence indicated improved knowledge and practice of hypothermia prevention using simple methods such as immediate drying and wrapping of a baby, which are important factors in preventing infant mortality (Falle, Mullany, Thatte, Khatry, LeClerq, Darmstadt, Katz and Tielsch 2009). Chale et al. (2016) stated that exclusive breastfeeding, encouraged by health workers, was an initiative of infant mortality reduction.

Community-based learning was highlighted as a low-cost intervention of reducing infant mortality. Women's group meetings provided forums for learning where women were encouraged to attend ante-natal clinics, seek care for any health problems during pregnancy as well as opt to deliver in health centres if facilities were available. (Sarbani et. al 2013). Furthermore, these participatory discussion groups (PDG) focused on planning for birth, safe delivery techniques, family health and prenatal visits. (Boone, Eble, Elbourne, Frost, Jayanty, Lakshminarayana, Mann, Mukherjee, Piaggio and Reddy, 2017).

In areas with limited access to health care facilities, interventions through primary health care workers (PHCW) were beneficial. (Setiawan, Dignam, Waters and Dawson 2016). According to Setiawan and colleagues, PCHWs outreach program gave mothers more knowledge on infant health, recognition of warning signs, treatment follow-ups and referrals to hospitals when needed. These visits made mothers content as they got more attention, and as a result, their children's health improved. Sarbani et al (2013) further suggested that these interventions could be replicated in other areas with high mortality rates.

Health curriculum. Initiation of paediatric friendly curriculum in educational institutions. Evidence showed that reinforcing paediatric nurse training is an intervention in reducing infant mortality rates. According to Coetzee (2014), promoting nursing research based on current child health care issues and practices would align teaching and practice, thereby improving care practices. Furthermore, updating curricula with evidence-based practices would determine good child health outcomes. Nursing towards reducing morbidity and mortality of children was the crucial role of paediatric nurses. For example, in South Africa, the key aim was to have at least one trained paediatric nurse in every children's ward and more in the other health care facilities. (Coetzee, 2014).

6 Discussion

6.1 Discussion of results

This study reviewed eleven articles looking at interventions of reducing infant mortality in developing countries. The current review indicates that vaccination programs play a significant role in infant mortality reduction, although Song et al. (2016) states that infant mortality rates are still quite high despite the availability of vaccines. This observation, to some extent, can be attributed to non-compliance of vaccination due to a misconception that parents might have which has also been documented by Delkhosh, Negarandeh, Ghasemi & Rostami (2014). However, some parents simply lack awareness of the importance and availability of vaccines as a result of limited access to health care services. (Delkhosh et. al 2014).

Delkhosh et al. (2014) therefore suggests that for primary health care providers to effectively educate parents about vaccination, they must be armed with vaccination knowledge and be prepared to deal with concerns, questions, or negative attitudes of parents towards their children's vaccination. WHO (2018) also recommends advising families to bring babies for timely vaccinations. Based on the results, it seems that introducing and implementing more vaccination programs would help reduce mortality rates. For such an intervention to be successful, healthcare workers must be equipped with the necessary knowledge and the resources.

The authors have identified that community-based training and outreach programs are some of the interventions of reducing infant mortality rates. Outreach programs by primary health care workers were beneficial to mothers, not only by imparting knowledge on their children's health, but also providing necessary training for traditional birth attendants on safe delivery practices. Similarly, Muttunga (2017) states that low socio-economic status of those living in rural areas led to higher rates of mortality because they had less access to better healthcare facilities. It seems that health care practices training, especially in rural areas with limited access to health care facilities gives knowledge and skills that when implemented could save lives of infants.

In terms of paediatric curricula, the current study indicates that there is need to review and update it with current evidence-based practices, Coetzee (2014). There appears not to be collaboration nor alignment between what is taught and what happens in practical settings thus hindering efforts of trying to reduce infant morbidity and mortality. A redesign of the paediatric nursing curricula that addresses infant mortality and morbidity should be considered. Based on the results of this study, policies such as longer paid maternity leave, exclusive breastfeeding and nutrition seem to have positive results in

reducing infant mortality. Obviously, child health outcomes can be improved when parents have more time to monitor and care for their infants at home with longer paid maternity leave (Jou, Kozhimannil, Abraham, Blewett, & McGovern, 2018; Nandi et. al, 2016; Rossin, 2011; WHO,2014).

Consequently, countries with high infant mortality must consider the introduction or extension of paid maternity leave. It is economically prudent to invest in the health of mothers and their newborn babies. The results further show that mothers are likely to have their infants vaccinated and exclusively breastfed with longer maternity leave policies in place as they have more time to spend at home with their infants. (Jou et. al, 2018; Nandi et. al, 2016; Rossin, 2011; WHO, 2014).

Moreover, paid maternity leave duration appears to be associated with lower incidences of hospitalisation of infants due to diseases of the gastrointestinal, acute and chronic respiratory infections (Jou et. al, 2018). The authors feel that these results have a potential to influence policies in low and middle-income countries that could provide mothers with longer paid maternity leave, to give them enough time to exclusively breastfeed for longer periods, vaccinate and provide adequate care for their babies without worrying about financial implications of leave without pay.

With regards to exclusive breastfeeding policies, Chale et al. (2016); WHO, (2014), state that exclusive breastfeeding policies could be used as interventions in reducing mortality rates in infants if they are enforced from the highest levels of leadership down to institutional and hospital levels. In the authors' opinion, if these policies could be implemented starting from the nurse or healthcare training schools in the lower income countries, they could help equip healthcare workers with the knowledge of the importance of exclusively breastfeeding in the fight against high infant mortality rates.

Exclusive breastfeeding seems to be effective in reducing infant mortality by providing much needed nutrition in infants, immunity, preventing sudden infant death syndrome and the risk of contracting diarrhoea and vomiting in infants, and premature infant complications (Gross, Taylor, Tomori, Coleman, Cook-Deegan, Majumder, & McGuire, 2019; Kresin, Pullins, & Horn, 2017). Likewise, nutritional supplementation and fluid intake in the form of oral rehydration salts seem to be other interventions that can reduce infant mortality rates in cases of diarrhoea and vomiting in infants (Biks et al. 2015; Bosomprah et. al, 2015; Doherty et al. 2016; Sarbani et al. 2013). Therefore, it would be imperative to encourage the practice of exclusive breastfeeding and nutritional supplementation as the best way to provide nutrition and innate immunity to new-borns and infants. Nursing curriculum could include maternal guidance and education modules in these interventions. Additionally, healthcare providers could be given in-service training to update the knowledges on exclusive breastfeeding and nutritional supplements.

Based on the results from this study, it looks like proper hygiene practices such as handwashing sanitation and clean water, and proper cord care at both hospital level and home care can be some of the interventions in infant mortality (Sarbani et al. 2013). Similar to this result, Baird, Smith, & DeBacco, (2015) state that clean cord care can be encouraged by discouraging some traditional practices of using herbs which may cause the umbilical cord to be infected. Considering these findings, the authors feel that traditional birth attendants in low resourced countries, could be given training by qualified nurses on basic hygiene practices, so they may be able to provide proper and informed guidance during antenatal care.

6.2 Critical appraisal, ethical considerations, validity and reliability, strengths and limitations

An assessment of the selected articles was undertaken to determine their viability. According to Hawker, Payne, Kerr, Hardey & Powell (2002), critical appraisal is done in three stages, namely, assessment of relevance, data extraction and scoring for methodological rigor. In the first stage, articles are eliminated based on their relevance to the specific research question, type of study, data source and context of material. In the data extraction stage, an assessment form is used to record full details of articles specifically with regards to the research question. The third stage of scoring for methodological rigor assesses the methodology of each of the empirical studies to grade them based on the reliability of the results. (Hawker et.al 2002.)

Hawker et al (2002), appraisal tool assesses nine areas of an article, i.e. abstract and title, introduction and aims, method and data, sampling, data analysis, ethics and bias, results, transferability or generalizability, and implications and usefulness (how important the findings are to policy and practice). The criteria used for scoring the quality of each article is 1 to 4; 4= Good, 3=Fair, 2=Poor, 1=Very Poor. The maximum score for any article is 36 whereas the minimum is 9. Articles scoring above 30 were considered for use in this research and the process is presented in appendix 2. (Hawker et.al 2002.)

Ethics in research is defined as the norms or standards for conduct that serve as a guideline for determining what kind of behavior is morally acceptable during research (Clark 2019). They ensure that abuse of research participants is minimized through obtaining informed consent, maintaining privacy and

confidentiality. The authors of this research chose articles that stated that prior to research being conducted the researchers had sought informed consent from the research participants, who were mostly adult women of childbearing ages. (Ibid). The chosen articles also stated that permissions from various ethical committees to conduct the research had been sought, prior to carrying out the research. However, two of the articles were mainly based on statistics obtained from various sources, hence the authors of this study considered them in conducting their research as no human subjects were used nor harmed. The authors also acknowledge that they have ethical responsibility of using the results and admitting that they are dealing with death of infants, which is quite a sensitive topic.

Plagiarism in this study was avoided by acknowledging the authors of the research articles that were used in the process of writing this literature review by using appropriate references, giving the relevant authors credit for their research (Bierer, & Barnes 2014). Data obtained during the research was reported accurately as obtained from the original sources to avoid fabricating and falsifying information and results (Bierer, et. al 2014).

To ensure that the research is valid, research must be free of errors that may render the study results as not applicable or relevant by avoiding bias (El-Masri, 2013). For the purpose of this study, the writers of this article were limited to sources that were offered free of charge from the JAMK database, therefore there was bias towards selecting available articles. There was also language bias as only articles written in English were selected, hence there is a possibility that there were more free articles available in other languages. These represent systematic article selection, which according to El-Masri, (2013) equates to selection bias. The articles selected by the authors were meticulously documented to ensure the validity of the research was maintained. The authors feel that the research was valid as the articles selected for this

study were obtained from research conducted in different countries and continents thereby reducing bias to only one particular region (El-Masri, 2013).

The authors of this research ensured that the principles of reliability are adhered to by documenting the steps taken during this research to give clarity to the research process used. This ensures that the research is easy to follow by a reader and similar results may be obtained if the research is repeated. The authors were also careful to give credit to the rightful authors of any information, thought or idea used in this research. The inclusion criteria used to select the articles was documented in the data collection criteria to give a clear outline of what the authors did and why they used the selected articles. (Grossoehme, 2014). The authors of this article feel that results of this study are reliable, and the interventions can be applied to middle- and high-income countries as well to reduce infant mortality rates.

The limitations of this research included cost limitations as only free articles were selected. This accorded the authors only a limited number of articles to choose from, hence some relevant studies might have been missed in the process. As the authors of this article are novices in research methodology, the research process may have not been as thorough. The strength of the research lies in the fact that there were two authors of this research which helped to reduce bias. The quality of the articles selected was evaluated using the Hawker critical appraisal tool ensuring that only quality articles were selected. The authors used recent articles with up to date information. (Hawker et.al 2002).

6.3 Conclusions and recommendations for further studies

The analysis of this study revealed that several low-cost interventions delivered at community levels in low income and developing countries can contribute to reductions in infant mortality. Simple things like women's' group

meetings provide forums for discussing and encouraging health practices like exclusive breastfeeding, nutrition and hygiene which all promote infants' health. Further research is needed in order to implement and sustain interventions such as training and equipping of traditional birth attendants with proper knowledge and skills as well as longer paid maternity leave policies. At the same time, more effort is required in reviewing and updating the paediatric curriculum to include relevant evidence-based practices focused on reducing infant morbidity and mortality.

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Appendices

Appendix 1- Summary of reviewed articles.

Author(s) (year), country	Purpose of the study	Participants and methods	Key findings	Critical Appraisal (Hawker et al. 2002,
Becker-Dreps et al (2017); Nicaragua	To evaluate changes in the incidence of pneumonia, bacterial meningitis, and infant mortality 5 years following introduction of the 13-valent pneumococcal conjugate vaccine in a "3+0" schedule.	Participants: Population of Nicaragua (n=410,860) Quantitative study. Data was collected by the Ministry of Health in Leo´n from public health facilities in all 10 municipalities in the Department.	During the first five years of program implementation, reductions were observed in health facility visits for pneumonia in immunized age groups and infant mortality, which would be hard to achieve with any other single public health intervention.	32
Biks et al. (2015); Ethiopia	To identify risk factors that are associated with infant mortality.	A prospective open cohort study involving (n=1752) infants (1472.4518 person years of follow-up) was undertaken	Exclusive breast feeding is the strongest predictor of infant survival in this predominantly rural setting where hygienic	34

		from November 2009 to August 2011. Kaplan-Meier Survival analysis was used to estimate infant mortality rate. Risk factors associated with infant mortality were assessed using multivariate Poisson regression.	standards are poor. Supporting mothers to exclusively breast feeding which is cost effective, safe and feasible strategy, can help reduce infant mortality.	
Boone et.al (2017); India	To investigate whether a package of interventions comprising community health promotion and provision of health services (including outreach and facility-based care) could lead to a reduction of the order of 25% in neonatal mortality.	Participants were married women <50 years old (n=14,137 control, n=15,532 intervention). They provided married women in the intervention villages with community health promotion (including health education via village health worker–led participatory discussion groups), outreach (including mobile teams providing antenatal check-ups), and facility-based care (including subsidised access to non-public health centres).	The study found that, of the live-born babies, 343 (6.9%) in the control arm and 303 (5.2%) in the intervention arm died in their first 28 days of life, suggesting that there were 92 fewer deaths as a result of the intervention. • Evidence of improved health knowledge and health practices including health service usage in the intervention arm compared to the control arm was found.	36
Bosomprah et. Al (2016); Zambia	The Programme for the Awareness and Elimination of Diarrhoea (PAED) was a pilot comprehensive	Participants population (n= < 85,000) births a year and (n= >320,000) children under 5 years of age. The study was a pre-post evaluation design.	The results showed a 34 % reduction in the probability of death among U5 children who had survived beyond 1 month, over the period of	36

	diarrhoea prevention and control programme aimed to reduce post-neonatal, all-cause under-five mortality by 15 % in Lusaka Province.	The Demographic and Health Survey style population-based two-stage approach was used to collect data at the beginning of the intervention and 3 years following the start of intervention. The Kaplan-Meier time to event analysis was used to estimate the probability of death.	implementation of PAED from 2012 to 2015. That is, in 2015, 1 in every 52 children born in Lusaka Province, who had survived the first 28 days, will die before attaining 5 years of age; as compared to 1 in every 34 children recorded at the start of the intervention. The results also showed that diarrhoea prevalence declined by about 20 % over the same period.	
Chale et al. (2016); Tanzania	To report the health workers' knowledge and practice on exclusive breastfeeding (EBF) in Tanzania, Universal exclusive breastfeeding (EBF) for the first 6 months is estimated to reduce infant mortality by 13–15% (9 million) in resource poor countries.	Participants: Health care workers (n=220) Methods: A cross-sectional and descriptive study with two parts: face-to-face interviews with health workers and observing health worker practical skills using a checklist. Logistic regression was used to determine factors associated with exclusive breastfeeding knowledge and desirable skills.	Less than 25% of healthcare workers surveyed had good knowledge of EBF. These findings identify the need for comprehensive training and mentoring of health workers on exclusive breastfeeding, making breastfeeding policies available and understood, along with supportive supervision and monitoring.	33
Coetzee et al. (2014); South Africa	To investigate the situation in South Africa's paediatric	Participants: Heads of school and child nurse educators from the four SANC-	The current lack of collaboration between clinician nurses and nurse educators means	31

	nurse training, plot ways to strengthen and expand post-graduate paediatric programmes to meet priority child health needs, and to build relationships between the various schools and stake-holders.	accredited universities and colleges that currently offer programmes in the three children 's nursing disciplines: child nursing, child critical care and neonatal critical care (n=38) Method: A one-and-a-half-day colloquium provided the setting for utilizing a participative World Café approach (The World Café 2008) to actively engage participants from a variety of constituencies in key discussions to generate data describing the current situation of child nurse training in the country. This participative approach was used to prevent discussion contributions being limited to those of a number of 'perceived experts' only.	that what is taught is not what usually happens in practice, and further, what happens in practice is based more on tradition than evidence. Nurse educators are concerned by what they see in practice settings while managers and clinicians are concerned that formally trained nurses need further courses in the programmatic approaches implemented to address child and infant mortality and morbidity.	
Doherty et al. (2016); Ethiopia	To examine changes in under-5 mortality, coverage of child survival interventions and nutritional status of	Estimates of child mortality generated using three Ethiopia Demographic and Health Surveys undertaken in 2000 (n=14072) ;2005 (n=13721) and 2011 (n=16702).	The mortality rate in children younger than 5 years decreased rapidly from 218 child deaths per 1000 live births (95% confidence interval 183 to 252) in the period 1987–1991 to	33

	children in Ethiopia between 2000 and 2011	Coverage indicators for high impact child health interventions were calculated and the Lives Saved Tool (LiST) was used to estimate child lives saved in 2011.	88 child deaths per 1000 live births in the period 2007–2011 (78 to 98). The prevalence of moderate or severe stunting in children aged 6–35 months also declined significantly. Improvements in the nutritional status of children and increases in coverage of high impact interventions most notably water, sanitation and hygiene (WASH) and oral rehydration solution (ORS) have contributed to the decline in under–5 mortality in Ethiopia.	
Falle et al. (2009): Nepal	To validate the potential of traditional birth attendants (TBAs) to improve neonatal health outcomes	Population: Randomly selected TBAs (n=93) Method: A survey with questionnaires.	Low-cost, evidence-based interventions for improving neonatal outcomes might be implemented by TBAs in settings where most births take place in the home and neonatal mortality risk is high. Continuing efforts to define the role of TBAs may benefit from an emphasis on their potential as active promoters of essential newborn care.	35
Nandi et.al. (2016;)	To evaluate whether paid maternity	Participants: Data from 20 countries.	More generous paid maternity-leave policies represent a	36

	leave policies affect infant mortality in low- and middle-income countries (LMIC)s.	A difference-in-differences approach was used. Samples from two sources of data, (1) live birth information collected from respondents surveyed as part of the Demographic and Health Surveys (DHS) in 20 countries and (2) measures of maternity leave policies. 1yr old infants (n= 282,836) and (n=304,294) neonates.	potential instrument for facilitating early-life interventions and reducing infant mortality in LMICs and warrant further discussion in the post-2015 sustainable development agenda.	
Sarbani et al. (2013); India	To determine whether a women's group intervention involving participatory learning and action has a sustainable and replicable effect on neonatal survival in rural, eastern India	Participants: Womens' groups in clusters, zone 1 (n= 244) and zone 2(n=274) Cluster- randomized controlled trial, between 2005 and 2008, these clusters were part of a randomized controlled trial of how women's group meetings involving participatory learning and action influence maternal and neonatal health. Between 2008 and 2011, groups in the original intervention clusters (zone 1) continued to meet to discuss post-neonatal issues and new groups in the	The results of this study indicate that the reduction in neonatal mortality associated with facilitating women's groups meetings involving participatory learning and action can be replicated in other areas with high neonatal mortality. The women's group intervention resulted in: better hygiene during delivery, particularly hand washing and clean cord care; improved thermal care of the neonate, with the largest mortality reduction occurring in winter; and an increase in exclusive breastfeeding in a	33

		original control clusters (zone 2) met to discuss neonatal health. Logistic regression was used to examine neonatal mortality rates after 2008 in the two zones.	context where neonates die of multiple overlapping causes, including prematurity, low birth weight and a high risk of sepsis.	
Setiawan et al. (2016); Indonesia	To evaluate community case management (CCM), a community-based service delivery model to improve children's wellness and longevity, involving the delivery of life-saving, curative interventions to address common childhood illnesses, particularly where there are limited facility-based services.	Population; Mothers and health workers (n=7) A qualitative study investigating the implementation of CCM.	The introduction of the CCM model may provide benefit for the community in rural areas in Indonesia in terms of increasing access to health care, especially access to lifesaving interventions for sick children. The employment of Primary Health Care Workers (PWHC) at village level in rural areas appears to have increased mothers' health literacy, their compliance with care protocols and health seeking behaviour.	35

Appendix 2- Critical Appraisal of the articles (Hawker et al. 2002)

Author	1 abstract /title	2 Introduction and aims	3 methods and data	4 sampling	5 Data analysis	6 Ethics and bias	7 Results	8 Transferability or generalizability	9 Implications and usefulness	total	Comments
Becker-Dreps et al (2017); United Kingdom	3	4	4	4	4	1	4	4	4	**32**	No mention of issues
Biks et al. (2015); Ethiopia	3	3	4	4	4	4	4	4	4	**34**	
Boone et.al (2017); India	4	4	4	4	4	4	4	4	4	**36**	
Bosomprah et. al (2016); Zambia	4	4	4	4	4	4	4	4	4	**36**	
Chale et al. (2016); Tanzania	4	4	4	4	3	4	4	3	3	**33**	

Coetzee, M (2014); South Africa	4	4	4	4	4	1	4	3	3	**31**	No mention of issues
Doherty et al.(2016) Ethi-opia	3	4	4	4	4	4	4	3	3	**33**	
Falle et al. (2009) Nepal	4	4	4	4	3	4	4	4	4	**35**	
Nandi et.al. (2016);	4	4	4	4	4	4	4	4	4	**36**	
Sarbani et al. (2013); India	3	4	4	4	4	2	4	4	4	**33**	
Setiawan et al. (2016); Indo-nesia	4	4	4	4	4	4	3	4	**4**	**35**	