

A systematic review to determine if text messages about health and development in infants and young children affect caregiver behaviour

by

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Declaration of originality

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DECLARATION OF ORIGINALITY

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Acknowledgements

“I can do all things through him who strengthens me.” (Philippians 4:13)

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List of Abbreviations

AIDS	-	Acquired Immunodeficiency Syndrome
ASHA	-	American Speech and Hearing Association
ECD	-	Early Childhood Development
HIV	-	Human Immunodeficiency Virus
LMIC	-	Low-Middle Income Country
mHealth	-	Mobile Health
PRISMA-P	-	Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols
RCT	-	Randomised Control Trial
SES	-	Socio-economic Status
SMS	-	Short Message Service
SPIDER	-	Sample, Phenomenon of Interest, Design, Evaluation, Research type
TB	-	Tuberculosis
USSD	-	Unstructured Supplementary Service Data
UNICEF	-	United Nations International Children Emergency Fund
WHO	-	World Health Organization

Abstract

Access to appropriate information can result in improved health and development outcomes for children. Providing information about health and developmental care via mobile devices (mHealth) can serve not only as curative healthcare but also as preventative health care in developing countries. Through mHealth programs, messages are sent by SMS or voice-recorded message. By reviewing the current state of evidence, the study aims to investigate if text messaging about health and development in young children has an effect on caregiver behaviour. This systematic review was conducted according to the PRISMA-P statement guidelines. Five databases were used to conduct this study and the search was not limited to a specific time period. Key words were used in various combinations within the different databases. Thematic analysis was used to organise and synthesize the information extracted from the selected studies. This review included 19 studies. Study designs included Randomised Control Trials (RCT's) (n=13, 68.4%), observational studies (n=3, 15.8%), and non-randomised control trials (n=3, 15.8%). Message content included educational information regarding health and development (89.5%), reminders (36.8%) and caregiver support (52.6%). Current evidence summarised from this review supports text messaging as an effective tool to change caregiver behaviour and child outcomes across a range of health and Early Childhood Development (ECD) related topics as the findings suggest increased caregiver comfort with basic infant health and development decisions. This may be attributable to information received via text message from health care professionals. Early childhood development has more limited evidence in terms of quantity and quality. More research is required in ECD and generally in low-to-middle income (LMIC) contexts.

Key terms

Health; development; caregiver; young children; text messaging; mHealth; prevention; support; education; systematic review

Chapter 1: Introduction

Chapter Aim:

The aim of this chapter is to provide background for the research problem identified and to present a literature review of related studies. The chapter concludes with the rationale, the research question, and the terminology as used in the dissertation.

Approximately 200 million children globally fail to reach their full developmental potential (Scherzer, Chhagan, Kauchali, & Susser, 2012). This failure could be due to a variety of biological and environmental risk factors. Biological risk factors include genetics and various diseases such as cholera, tuberculosis and malaria (National Department of Health, 2015b). More so, environmental risk factors such as poverty, absent parents, malnutrition, and lack of appropriate parental knowledge, significantly influence children's health and development (Medina Alva et al., 2015). Children born into poorer families with a lower socio-economic status (SES) are more likely to experience adverse health and developmental outcomes based on their exposure to negative conditions, than those born into higher earning families (Noble et al., 2015). Risk factors may therefore interfere with the stimulating and nurturing environment that is vital for optimal early childhood development (ECD) and health outcomes (Guyer et al., 2009).

As a result, it is important to intervene early to promote health and development, and to prevent potential chronic diseases and delays later in adulthood (Minniss, Wardrope, Johnston, & Kendall, 2013). According to the World Health Organisation (2009), there are three levels of prevention including: primary, secondary and tertiary. Primary prevention involves preventative measures introduced before the onset of illness, disease, or injury (for example, immunization reminders). Secondary prevention includes preventative measures that may lead to early identification and treatment of health or developmental issues (for example, screening tests). Tertiary prevention includes rehabilitation following health and developmental issues (for example, speech or occupational therapy) (World Health Organization, 2019). Health care professionals aim to implement primary preventative measures as the first three

years of a child's life are a critical period for brain development where the brain is at its highest plasticity and optimal development may occur (Maleka, Van Der Linde, Glascoe, & Swanepoel, 2016; Slemming & Saloojee, 2013). If this window of opportunity is missed, it becomes increasingly difficult to encourage and achieve successful ECD (Siddiqi, Hertzman, Irwin, & Hertzman, 2011).

The primary influence on a child's development is the family (UNICEF, 2007; Weinert, Linberg, Attig, Freund, & Linberg, 2016). Parental involvement and responsive parenting activities are important for language, cognitive and socio-emotional development (Frongillo, Kulkarni, Basnet, & de Castro, 2017; Noble et al., 2015; Smith, Gibbard, & Higgins, 2017). Children spend a lot of time engaging in family interactions in their day-to-day lives where their caregivers model language and social behaviour (Turiel, 2010). Yet, parents with a low SES experience higher levels of stress and depression and may have feelings of low self-worth, affecting caregiver-child attachment and bonding (Medina Alva et al., 2015). Secure attachment between a child and a caregiver is a prerequisite for healthy childhood development (Rawatlal, Pillay, & Kliewer, 2015). This attachment includes consistent caring, support and affection from a trusted caregiver (Turiel, 2010). The family does not only include the child's parents but also grandparents, extended family members and caregivers. The community which the family belongs to is often the main source of knowledge regarding child rearing practices and other norms relating to child health care and development (Siddiqi et al., 2011) These child rearing practices may clash with accepted norms of society, government laws, or even with internationally accepted human and child rights (Siddiqi et al., 2011). Furthermore, parental exposure and access to information regarding acceptable child rearing practices may be hindered by poverty and other socioeconomic factors (Frongillo et al., 2017). A positive link between parental access to information regarding prenatal and postnatal education and improved ECD outcomes has been reported (Gray, Bick, & Chang, 2014; Sarwar, 2015; Seebregts, Barron, Tanna, Benjamin, & Fogwill, 2016).

Access to appropriate information can also result in improved health outcomes (Hall, Cole-Lewis, & Bernhardt, 2015). Approximately 776 million adults lack basic health literacy skills (Latif et al., 2017). Health literacy is a term used to describe parents ability to access, comprehend and utilise specific health information in ways to

promote optimal health for their children (Davis, Jones, Logsdon, Ryan, & Wilkerson-Mcmahon, 2013). Adequate parental health literacy is vital for knowledge of health care and health conditions, disease prevention, compliance with health recommendations, a health management plan for their children as well as their overall health status (Davis et al., 2013; Zhuang, Xiang, Han, Yang, & Zhang, 2016). Health education resources are not easily accessible, especially for those living with a low SES, and more effective measures are needed to promote health literacy (Zhuang et al., 2016).

Around the world, specifically in LMIC's, people may not receive the same quality of information and health care services based on their location (Slemming & Saloojee, 2013) as there are too few professionals to meet the needs of the population (Maleka et al., 2016; Mayosi et al., 2014). Many of these countries may lack resources and access to health care (Schoenberger, Phillips, Mohiuddin, McNeese, & Scarinci, 2013) due to geographical barriers, poor infrastructure, and lack of funds to travel (Laidlaw et al., 2017). The use of mobile phones in the provision of preventative healthcare services is becoming increasingly popular globally (Alam, D'este, Banwell, & Lokuge, 2017). Mobile phones provide one of the largest platforms through which to connect with new mothers and pregnant women (United Nations Foundation, 2015). Affordable, scalable, trackable and targeted mobile phone based health initiatives may be a promising addition in addressing maternal and child health problems in order to achieve maximum impact (Sarwar, 2015).

Many health related smart phone applications and websites are available and target a wide range of health behaviours, including smoking cessation, weight loss (Zhuang et al., 2016), HIV and AIDS prevention, as well as prenatal and antenatal care (Seebregts et al., 2016). However, smartphone applications are often not easily accessible to individuals living in rural areas, as a smartphone and internet access is a requirement (Seebregts et al., 2016). To overcome this challenge, health promotion text messaging, available on all mobile devices, has been implemented in various countries to reach areas of the community where the majority of the population may be living in poverty and lack access to information and health services (Laidlaw et al., 2017). These initiatives may be taking advantage of the ever increasing rate of mobile

phone ownership internationally, i.e. in South Africa, 90% of the population is reported to own a mobile phone (Peter, Barron, & Pillay, 2015).

With the use of this technology, the health sector has the potential to meet the demand for appropriate health care services (Peter et al., 2015) as awareness campaigns and information giving are central to the role of health care services (Sarwar, 2015). Providing health and developmental care information via mobile devices (mHealth) can serve not only as curative healthcare, but also as preventative health care in developing countries (Laidlaw et al., 2017). Evidence has shown that there are more caregivers using mHealth services in areas with higher levels of poverty and of low birth weight infants in the United States of America (Whittaker et al., 2012). Studies also found that receiving SMSs improved health literacy (namely health awareness and health knowledge) and even encouraged changing of unhealthy behaviours (Zhuang et al., 2016). There have been many positive outcomes related to this service delivery medium, including an increase in antenatal and postnatal care visits, a higher rate of exclusive breastfeeding, higher immunisation rates (Sarwar, 2015), appropriate care seeking behaviour amongst caregivers (Watkins, Robinson, & Dalious, 2013) as well as adherence to family planning schedules (Alam et al., 2017).

Health messages on child health and development can be delivered by short message service (SMS) or unstructured supplementary service data (USSD) as neither requires smartphones (Seebregts et al., 2016). Text messaging is a simple, popular and familiar technology that can be integrated into everyday life (Whittaker et al., 2012). Text messages are universally appealing, non-controversial, and free for end-users (Whittaker et al., 2012). The success and acceptability of a messaging system are highly dependent on specific tailoring of messages (Laidlaw et al., 2017). Messages need to be adapted in order to be sensitive to cultural and demographic factors such as age and gender, audience level of understanding, literacy skills, language capabilities as well as technology skills (Laidlaw et al., 2017).

Through mHealth programs, messages are sent by SMS or voice-recorded message based on the preference of the individual subscriber. Some of the programs, such as *Chipatala Cha Pa Foni* (CCPA) and *Text4Baby* have a toll-free hotline where the majority of telephone calls are easily solved with appropriate health information and fewer people are thus referred to health care facilities (Watkins et al., 2013). Messages

to caregivers cover typical developmental domains (i.e. growth, cognitive, linguistic, social and emotional development) (Slemming & Saloojee, 2013), safety, feeding and nutrition, when and how to access health care, emotional support for mothers, immunizations (Whittaker et al., 2012) as well as mother-child attachment and bonding, which are important aspects of ECD and health (United Nations Foundation, 2015).

Current health care services and mHealth initiatives are mainly focused on the rehabilitation of existing delays/disorders (Slemming & Saloojee, 2013), such as congenital abnormalities, neonatal sepsis, HIV AIDS, Tuberculosis (TB), Malaria, cancer, cardiovascular and respiratory diseases, and diabetes (National Department of Health, 2015a; World Health Organization, 2012). Health messages targeting caregiver education will aid in early identification of children who may be at risk for adverse ECD and health outcomes as well as the prevention of health problems and developmental delays/disorders (Slemming & Saloojee, 2013). ECD targeted mHealth programs, such as *Aponjon* in Bangladesh, *Wazazi Nipendeni* in Tanzania, *CCPF* in Malawi, and *MomConnect* in South Africa, have been implemented in a number of resource limited settings and are demonstrating high success rates in terms of breastfeeding, attendance to antenatal care visits, and the use of bed nets (Peter et al., 2015). These services are free for caregivers which reduce access barriers to information. A text messaging system may also provide a sense of safety and privacy for women who may feel ostracised and ashamed as information is delivered directly to the individual's phone (United Nations Foundation, 2015).

Although mHealth initiatives show promising outcomes, it is difficult to measure the direct impact on mothers and young children (Whittaker et al., 2012). By reviewing the current state of evidence, the current study aims to investigate if text messaging about health and development in young children has an effect on caregiver behaviour.

Chapter 2: Method

Chapter Aim:

The aim of this chapter is to state the purpose of the research study as well as to describe the design, study criteria and selection, as well as the data extraction and risk of bias assessment procedures. The chapter elaborates on the methods used in the systematic review as the restrictions on the article length do not allow for comprehensive descriptions.

2.1. Research aim

To determine if text messages about health and development in infants and young children has an effect on caregiver behaviour.

2.2. Research design

A systematic review of relevant literature was conducted to investigate if text messages about health and development in infants and young children has an effect on caregiver behaviour. A systematic review allows the researcher to identify current evidence regarding the effectiveness of ECD targeted health messaging services. Systematic reviews are important in the field of health care as clinicians use them to keep up to date with the latest research in their field and as a starting point for appropriate, evidence based practice guidelines (Shamseer et al., 2015). This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) statement guidelines (Shamseer et al., 2015). PRISMA-P is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses. It ensures/encourages/facilitates transparent and complete reporting in systematic reviews (Shamseer et al., 2015).

2.3. Protocol and registration:

This study was registered with PROSPERO, which is an international database of systematic reviews dedicated to topics related to health and social care. Specific key characteristics are recorded and preserved as a permanent record. A systematic review should be registered with this database at the beginning stages to avoid any possible duplication and to allow for comparison between reported review methods and what was planned in the protocol (Shamseer et al., 2015).

2.4. Ethical considerations

Ethical clearance was obtained from the Research Ethics committee of the Faculty of Humanities, University of Pretoria (HUM009/0219) (appendix A). This systematic review included a number of journal articles and therefore no participants were used to conduct this study.

The following principles were adhered to (American Speech-Language-Hearing Association, 2009):

Plagiarism:

To avoid plagiarism, all resources that contributed to this research study were carefully adapted, accurately cited in text and included in a comprehensive reference list at the end of the research document.

Bias:

Selection and publication bias was carefully considered. Selection bias refers to subjective selection of data for analysis or studies to be reviewed (Joober, Schmitz, Annable, & Boksa, 2012). This resulted in a sample that was not a representative of the data set that was intended to be reviewed. In an attempt to avoid selection bias, the reviewers established search strategies in advance, including using keyword searches, setting inclusion/exclusion criteria, and manually checking data.

Publication bias refers to the incomplete or nonpublication of negative research results (Joober et al., 2012). It was important to evaluate the risk of bias and the quality of

evidence in individual studies and across studies to ensure that a thorough and accurate review is established (Joober et al., 2012). Multiple databases were searched using a variety of search terms in order to review a large amount of relevant articles. This helped the reviewer avoid publication bias in selection of studies. Risk of publication bias within each included study was independently assessed by the initial reviewer. A second reviewer then rated 20% of these articles. A third reviewer mediated in situations of disagreement. The agreement between reviewers as well as the risk of bias was assessed using the Cochrane guidelines (Higgins & Green, 2008)(randomised controlled trial studies), Newcastle-Ottawa Scale (Wells et al., 2018)(non-randomised) as well as the American Speech and Hearing Association (ASHA) levels of evidence (Heneghan, Smith, & Rushton, 2015).

2.5 Information sources:

This search made use of specific topic based strategies designed for specific databases from the start of January 2019. Only English articles were considered with no geographical restrictions. The search was not limited to a specific time period. The date of the last search was at the end of June 2019. The specific databases that were used to conduct this study include: Cochrane Library, MEDLINE (Ovid), PubMed, Scopus and Web of Science Core Collection. These databases were selected as they cover a wide variety topics related to health care.

2.6. Search strategy:

The search strategy includes the study population using terms and keywords derived from scoping search and expertise in the subject field. Key words were used in various combinations within the different databases. The researcher also reviewed the references of the articles found and included articles that were not identified in the search. Concept mapping was also used to generate a wider array of key words (Wilson, Mandich, & Magalhães, 2016). A concept map is a tool used to visualise the processes of development of an idea. This helped to organise, synthesise and structure the information in a logical representation in order to understand the relationship between concepts (Wilson et al., 2016).

Combinations of keywords that were searched:

1. “Health messaging” OR “health promotion messaging” OR “health information messaging” AND “caregiver education” OR “parent education” OR “parent training” OR “parent guidance”) AND (“health” OR “development”) AND (“young children” OR “toddlers” OR “babies” OR “infants”)
2. “Mobile phone message” OR “cell phone message” OR “short message service” OR “text message” OR “voice messaging” AND (“caregiver education” OR “parent education” OR “parent training” OR “parent guidance”) AND (“health” OR “development”) AND (“young children” OR “toddlers” OR “babies” OR “infants”)
3. “Mobile health” OR “mHealth” AND (“caregiver education” OR “parent education” OR “parent training” OR “parent guidance”) AND (“health” OR “development”) AND (“young children” OR “toddlers” OR “babies” OR “infants”)
4. “Telepractice” OR “telehealth” AND (“caregiver education” OR “parent education” OR “parent training” OR “parent guidance”) AND (“health” OR “development”) AND (“young children” OR “toddlers” OR “babies” OR “infants”)
5. “Mobile technology” OR “Text message intervention” OR “medical mobile innovation” AND (“caregiver education” OR “parent education” OR “parent training” OR “parent guidance”) AND (“health” OR “development”) AND (“young children” OR “toddlers” OR “babies” OR “infants”)

Full electronic search strategy with limits:

The following table indicates the number of responses each database received using different combinations of search words and phrases indicated above.

Table 2.1: Selection process of studies

	PubMed	Medline	Scopus	Web of Science Core Collection	Cochrane Libraries	Total
<i>Selected fields</i>	<i>title/ abstract</i>	<i>title/ abstract</i>	<i>title/ abstract/ keyword</i>	<i>all fields</i>	<i>title/ abstract/ keyword</i>	
SEARCH TERMS	Number of hits					
1. (message OR messaging) AND development AND (infants OR children) AND (caregiver OR parent OR mother)	55	1288	866	846	11	3066
2. (message OR messaging) AND health AND (infants OR children) AND (caregiver OR parent OR mother)	167	349	2447	1936	17	4916
3. (mobile health OR mHealth) AND development AND (infants OR children) AND (caregiver OR parent OR mother)	15	135	247	374	7	778
4. (mobile health OR mHealth) AND health AND (infants OR children) AND (caregiver OR parent OR mother)	53	27	1023	919	10	2032
Total number of results	290	1799	4583	4075	45	10792

2.7 Eligibility criteria:

The SPIDER tool for qualitative evidence synthesis (Methley, Campbell, Chew-Graham, McNally, & Cheraghi-Sohi, 2014) was used to evaluate eligibility criteria:

- **(S) Sample:** Studies conducted on the outcomes of health messaging systems related to caregiver behaviour change regarding the health and development of their infants and young children.

- **(PI) Phenomenon of Interest:** A health messaging system targeting caregiver knowledge and behaviour about health and development of their infants or young children.
- **(D) Design:** Observational, cohort, case control, and randomised control trials.
- **(E) Evaluation:** Any reported measure of outcomes from a health messaging system as a service delivery model.
- **(R) Research type:** Qualitative, quantitative and mixed-methods research could be searched for.

Inclusion criteria:

- Studies conducted on the effect of a text messaging system related to caregiver behaviour change or child outcomes regarding the health and development of their infants and young children were included in this study;
- The search was not limited to a specific time period;
- Only English studies were included;
- SMS effectiveness needed to be the key element of the intervention; however, studies were considered if other modes of intervention were incorporated (e.g. face-to-face visits or educational documents);
- SMS content was required to be educational or supportive in nature. Reminder systems were considered if coupled with a supportive or educational message;
- Any pre-and post test study designs were considered. Exceptions were made for observational studies that reported on caregiver behaviour change;
- All study populations (high, low and middle income countries) were included;
- Participants within selected studies needed to include caregivers of at least one child under the age of 5 years old.

Exclusion criteria (See appendix B):

- Studies were excluded if the design did not include pre-post test data (ie. systematic review or study protocols)
- Studies were excluded if the outcomes did not report on caregiver behaviour change or child outcomes (ie. a feasibility study or caregiver's acceptance of this type of intervention)

- Articles were excluded if the children of caregivers within the studies were over the age of 5 years old.
- Studies were excluded if they involved the use of mobile phone applications or web-based programs requiring internet access.
- Studies using SMSs exclusively as a reminder system were excluded.
- Articles describing the use of a SMS response system to collect data on health and development of young children were excluded.

2.8 Study selection:

An online software programme, DistillerSR, was used to select studies. This is an online tool that allows reviewers to work collaboratively in screening and selecting relevant studies. The program includes citation screening, elimination of duplicate citations, full text review, risk of bias assessment, extraction of study characteristics and outcomes, and the export of data and references.

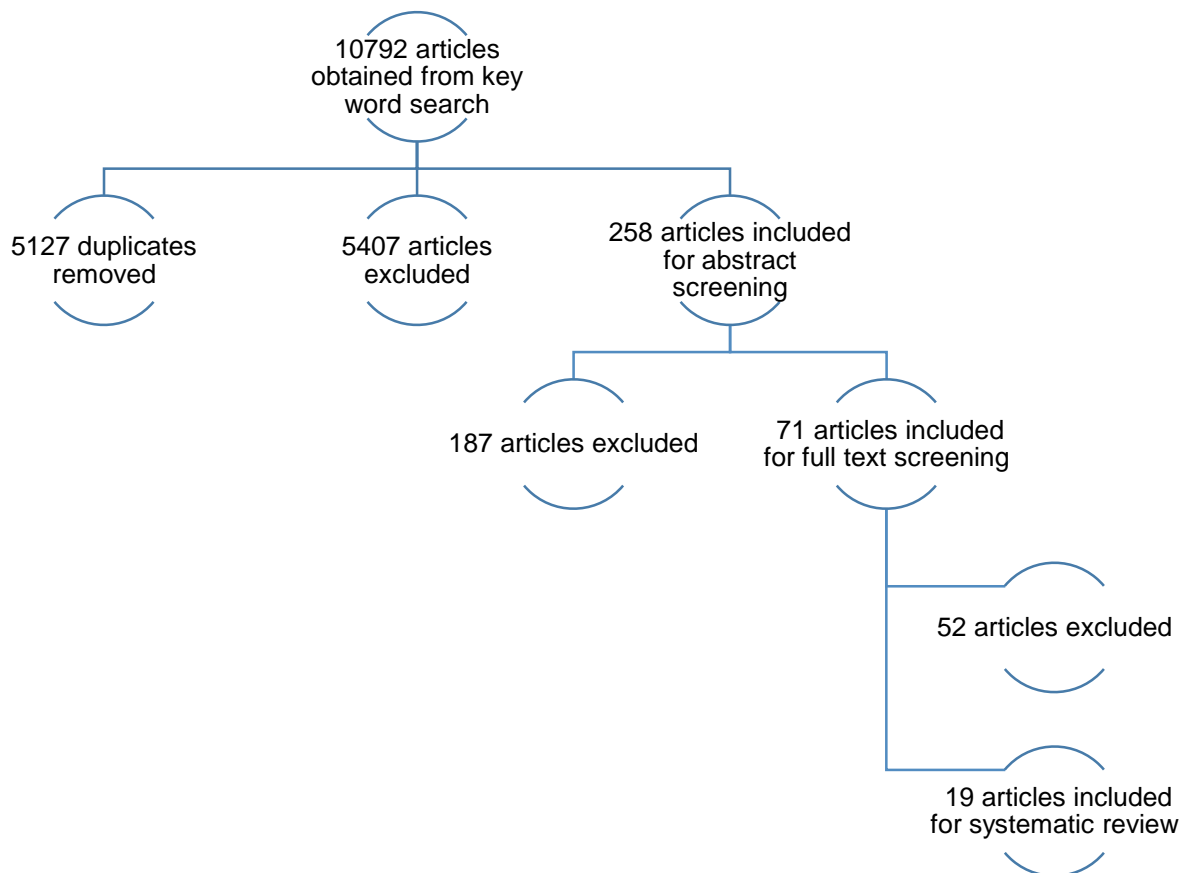


Figure 2.1: Figure illustrating the number of results obtained, how the results were narrowed down and the number of studies that were included.

The eligibility criteria outlined above was carefully considered when selecting studies. According to these specifications, this study aimed to find any articles reporting the outcomes and effectiveness of text messaging systems related to caregiver behaviour regarding the health and development of their infants and young children. Reviewed studies included observational, cohort, case control and randomised control trials (RCTs) and were qualitative, quantitative, or mixed methods in design. 5407 articles were excluded (see *figure 1*) as they did not meet the specified inclusion criteria (60.32%).

2.9 Data collection and analysis:

Using a data extraction sheet (see appendix C), the researcher extracted data from relevant resources. A second and third reviewer then checked the extracted data for consistency and clarity (Shamseer et al., 2015).

Data items:

The extracted data included the title, the author, the year of publication, the country in which the study was conducted, the method of messaging, the type of message content, the level of evidence, the length of intervention period, the target population and age range of participants, the hypothesised outcomes, the reported outcomes/effectiveness, and the statistically significant effect of the intervention on the target population. Data was extracted according to the specific eligibility criteria outlined above (Shamseer et al., 2015).

Summary measures:

Data was presented in a table format. This allowed for the qualitative comparison of; the mHealth program, the content of the messages, the use of other materials, the period of time since implementation, and the various measures of success. Main themes were identified within the data and sub-themes were derived from the study outcomes. All results were reported in the context of overall study quality (Heneghan et al., 2015).

Synthesis of results:

Thematic analysis was used to organise and synthesise information extracted from the selected studies. Thematic analysis is a method used to interpret implicit and explicit data items (Guest, MacQueen, & Namey, 2012). The researcher then judged the similarity of the studies, the mechanism of intervention or exposure as well as follow up times in order to combine all the relevant studies.

Chapter 3: Research article

Chapter Aim:

The aim of this chapter is to present the systematic review article as submitted to *Early Child Development and Care* on 11 November 2019. Please take note that the format of the article may differ from the rest of the dissertation as the journal has specific guidelines informing the format of the article.

Early Child Development and Care

Do text messages about health and development in young children have an effect on caregiver behaviour? A systematic review

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Do text messages about health and development in young children have an effect on caregiver behaviour? A systematic review

Abstract

Access to appropriate information can result in improved health and development outcomes in children. Health promotion text messaging has been implemented in various countries to reach communities where the majority of the population may be living in poverty and lack access to information and health services. This systematic review investigated the effect of providing information, regarding health and development in young children using text messages, on caregiver behavior. Studies were retrieved from five different databases using primary search phrases. Nineteen studies were identified, including RCT's, observational studies, and non-randomized control trials. Message content included educational information regarding health and development, reminders and caregiver support. This study revealed that text messaging is an effective tool to influence caregiver behaviour and child outcomes in health. In child development, there is limited evidence, both in quality and quantity and necessitates more research. More research is also required in LMICs.

Keywords: development, health, text messaging, young children, caregiver behaviour

Introduction

Around the world, approximately 200 million children do not reach their full developmental potential due to exposure to risk factors (Mo et al., 2014; Scherzer et al., 2012). A range of risk factors interfere with a nurturing environment and stimulation that is vital for optimal early childhood development (ECD) and health (Guyer et al., 2009), including inadequate nutrition and family care (Frongillo et al., 2017). The first three years of a child's life is when the brain is at its highest neural plasticity (Georgieff, Brunette, & Tran, 2015). It is vital to intervene

early to promote child development and well-being whilst preventing developmental delays and health related problems (Minniss et al., 2013).

The primary influence on a child's development is the family (UNICEF, 2007; Weinert, Linberg, Attig, Freund, & Linberg, 2016). Consistent caring, support and affection from a trusted caregiver is a protective factor against risks and a prerequisite for healthy childhood development (Mo et al., 2014; Rawatlal et al., 2015; Siddiqi et al., 2011) including language, cognitive and socio-emotional development (Frongillo et al., 2017; Noble et al., 2015; Smith et al., 2017). Inadequate caregiving conditions interfere with successful development (Biglan, Flay, Embry, & Sandler, 2012). Caregivers' knowledge of child health and development plays a key role in the care they provide (Vorster, Sacks, Amod, Seabi, & Kern, 2016). Therefore, interventions promoting successful ECD and health outcomes need to be targeted towards caregivers.

Caregiver's access to information results in improved health and developmental literacy (Jeyaseelan & Sawyer, 2017). A positive link between parental access to information regarding prenatal and postnatal education and improved health ECD outcomes has been reported (Gray et al., 2014; Hall et al., 2015; Sarwar, 2015; Seebregts et al., 2016). Adequate parental health literacy is vital for disease prevention, compliance with health recommendations, a health management plan for their children as well as their overall health status (Davis et al., 2013; Zhuang et al., 2016). Globally, however, an estimated 776 million adults lack basic health literacy (Latif et al., 2017). Maternal and child health education resources are also not easily accessible, especially for those living in low income countries (Obasola & Mabawonku, 2018). More accessible measures are therefore required to promote health and developmental literacy in general (Zhuang et al., 2016).

In low and middle income countries (LMICs) the attainability of information as well as access to appropriate health care services varies greatly based on an individual's location (Hamdani, Minhas, Iqbal, & Rahman, 2015; Slemming & Saloojee, 2013) and availability of professionals to meet their needs (Mayosi & Benatar, 2014). Appropriate resources, social support structures, financial assistance and community infrastructure, are considered to be important factors of parenting practices and child outcomes. (Taliep, Ismail, & Titi, 2018). The use of mobile phones in the provision of preventative healthcare services is becoming an increasingly utilized avenue (Alam et al., 2017). These services are referred to as a component of mobile health (mHealth). Affordable, scalable, trackable and targeted mobile phone based initiatives may be a promising addition in addressing maternal and child health and development problems in order to achieve maximum impact (Sarwar, 2015).

Messaging to promote health and early childhood development is a primary mHealth strategy that has been implemented in various countries, particularly to reach areas where poverty and poor access to information and health services is characteristic (Laidlaw et al., 2017). Health messages can be delivered by short message service (SMS) or unstructured supplementary service data (USSD) as neither requires smartphones (Seebregts et al., 2016). These initiatives are taking advantage of the ever increasing rate of mobile phone ownership and penetration internationally (GSMA, 2019). Studies are demonstrating that receiving SMSs could improve health and developmental literacy and even encouraged changing unhealthy behaviors (Jeyaseelan & Sawyer, 2017; Zhuang et al., 2016). Adequate developmental literacy in caregivers will result in the understanding of typical key developmental milestones, knowledge of risk for developmental delays, recognizing developmental delays, knowledge of long-term consequences of an unaddressed delay, knowledge of where to seek appropriate health and development information, as well as appropriate self-help and help-seeking behaviour (Jeyaseelan & Sawyer, 2017). The level of understanding, literacy, language capabilities as

well as technology skills required of the audience may however impact the success and acceptability of a messaging system if not taken into consideration (Laidlaw et al., 2017).

Health and ECD targeted mHealth text messaging programs, such as *Aponjon* in Bangladesh, *Wazazi Nipendeni* in Tanzania, *CCPF* in Malawi, and *MomConnect* in South Africa, have been implemented in a number of LMICs and are demonstrating high success rates in terms of early breastfeeding, attendance to antenatal care visits, and the use of bed nets to prevent malaria (Peter et al., 2015). These services are free for caregivers, which reduces access barriers to information. Messages received from these programs cover typical developmental stages (i.e. growth, cognitive, linguistic, social and emotional development) (Slemming & Saloojee, 2013), safety, feeding and nutrition, when and how to access health care, emotional support for mothers, immunizations (Whittaker et al., 2012) as well as mother-child attachment and bonding. All of these are important aspects of ECD and health (United Nations Foundation, 2015).

Using messaging for health and early development has the potential to reduce some of the burden on health care services (Peter et al., 2015). Health messages targeting caregiver education could support early identification of children who may be at risk for adverse ECD and health outcomes as well as towards prevention of developmental delays/disorders (Slemming & Saloojee, 2013). Although some mHealth initiatives have demonstrated promising outcomes, it is difficult to measure the general effectiveness in terms of impact on mothers and young children (Whittaker et al., 2012). This systematic review therefore investigated what effect provision of information regarding health and development in young children using text messages has on caregiver behavior.

Method

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) statement guidelines (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009) (appendix D) was used to conduct this systematic review. A systematic review was conducted of studies that investigated the effect of providing information about health and development in young children using text messages on caregiver behavior.

Search strategy

Five databases were used: Cochrane Library, MEDLINE (Ovid), PubMed, Scopus and Web of Science Core Collection. Titles and abstracts were searched for the terms outlined in table 1.

Table 3.1: Selection process of studies.

	Pubmed	Medline	Scopus	Web of Science Core Collection	Cochrane Libraries	Total
	<i>title/ abstract</i>	<i>title/ abstract</i>	<i>title/ abstract/ keyword</i>	<i>all fields</i>	<i>title/ abstract/ keyword</i>	
SEARCH TERMS	Number of hits					
1. (message OR messaging) AND development AND (infants OR children)	55	1288	866	846	11	3066

AND (caregiver OR parent OR mother)						
2. (message OR messaging) AND health AND (infants OR children)	167	349	2447	1936	17	4916
AND (caregiver OR parent OR mother)						
3. (mobile health OR mHealth) AND development AND (infants OR children)	15	135	247	374	7	778
AND (caregiver OR parent OR mother)						
4. (mobile health OR mHealth) AND health AND (infants OR children)	53	27	1023	919	10	2032
AND (caregiver OR parent OR mother)						
Total number of results	290	1799	4583	4075	45	10792

Study selection and evaluation

All references obtained from the keyword search were uploaded to an online software program (DistillerSR, Evidence Partners, Ottawa, Canada) which was used to screen and select studies. This online program allowed authors to collaborate and mediate to avoid selection bias. Of the 10792 results, 5127 duplicates were removed. The first author then screened the titles and abstracts of the remaining studies to determine if they were to be excluded or reviewed in full. Eighty-six articles were selected for full text evaluation to confirm eligibility for inclusion.

Inclusion and exclusion criteria

Studies conducted on the effect of a text messaging system related to caregiver behaviour change or child outcomes regarding the health and development of their young children were included in this study. The search was not limited to a specific time period and only English studies were included. Studies were accepted if they included other modes of intervention (eg. Face-to-face visits or educational documents), however, SMS effectiveness needed to be the key element of the intervention. SMS content was required to be education or supportive in nature. Some reminder systems were considered if coupled with a supportive or educational message. Any pre-and post test study designs were considered. Exceptions were made for observational studies that reported on caregiver behaviour change. All study populations, from high and low income countries, were included; however, participants within studies needed to include caregivers of at least one child below the age of 5 years.

Articles were excluded if the reported outcomes or study design (such as systematic reviews or study protocols) was not in line with inclusion criteria (60.32%); if participants included caregivers of children over the age of 5 years old (9.52%); if text messaging was used exclusively as a reminder system, or if a mobile phone application or any web-based programs

requiring internet access was used (30.16%). Articles describing the use of a SMS intervention to collect data on health and development of young children were also excluded.

Data extraction management

Data was extracted according to specific eligibility criteria based in the SPIDER tool for the synthesis of qualitative evidence (Methley et al., 2014). All articles that met these criteria were eligible for inclusion. The extracted information included characteristics such as the title, author, the country in which the study was conducted, the year of publication, the study design, the level of evidence, the method of messaging, the time period of the study, the target population, the hypothesized primary and secondary outcomes, as well as the final outcome or effectiveness of the intervention.

Articles were divided in order to perform a qualitative and quantitative comparison of the mHealth program or method of messaging, the specific outcome category (health, development or both), and measures of success. Information extracted from the selected studies was organized and synthesized according to thematic analysis. Main themes were identified within the data and sub-themes were derived from the study outcomes. All results are reported in the context of overall study quality (Heneghan et al., 2015).

Bias

The risk of publication bias (see appendix E and F) and the quality of evidence in individual studies and across studies was evaluated to ensure that a thorough and accurate review was established (Jooper et al., 2012). The Cochrane risk of bias assessment is used to review the quality randomized controlled trials. It includes five domains (selection, performance, attrition, reporting, and other) in which the author classifies the content of the article as either low, high or unclear risk (Higgins & Green, 2008). The author's judgment is supported with evidence from the reviewed article, other relevant sources, as well as the authors' explanation (Higgins

& Green, 2008). The Newcastle-Ottawa scale (NOS) was used to analyze the quality of non-randomized studies (Wells et al., 2018). To avoid selection bias, searching strategies were established in advance. This included keyword searches, defining specific inclusion and exclusion criteria, and manually checking extracted data.

Results

Seventy-one articles were reviewed in full. Fifty-two of these articles were found to be unrelated to the study subject, resulting in 19 articles that met inclusion and exclusion criteria (see figure 1).

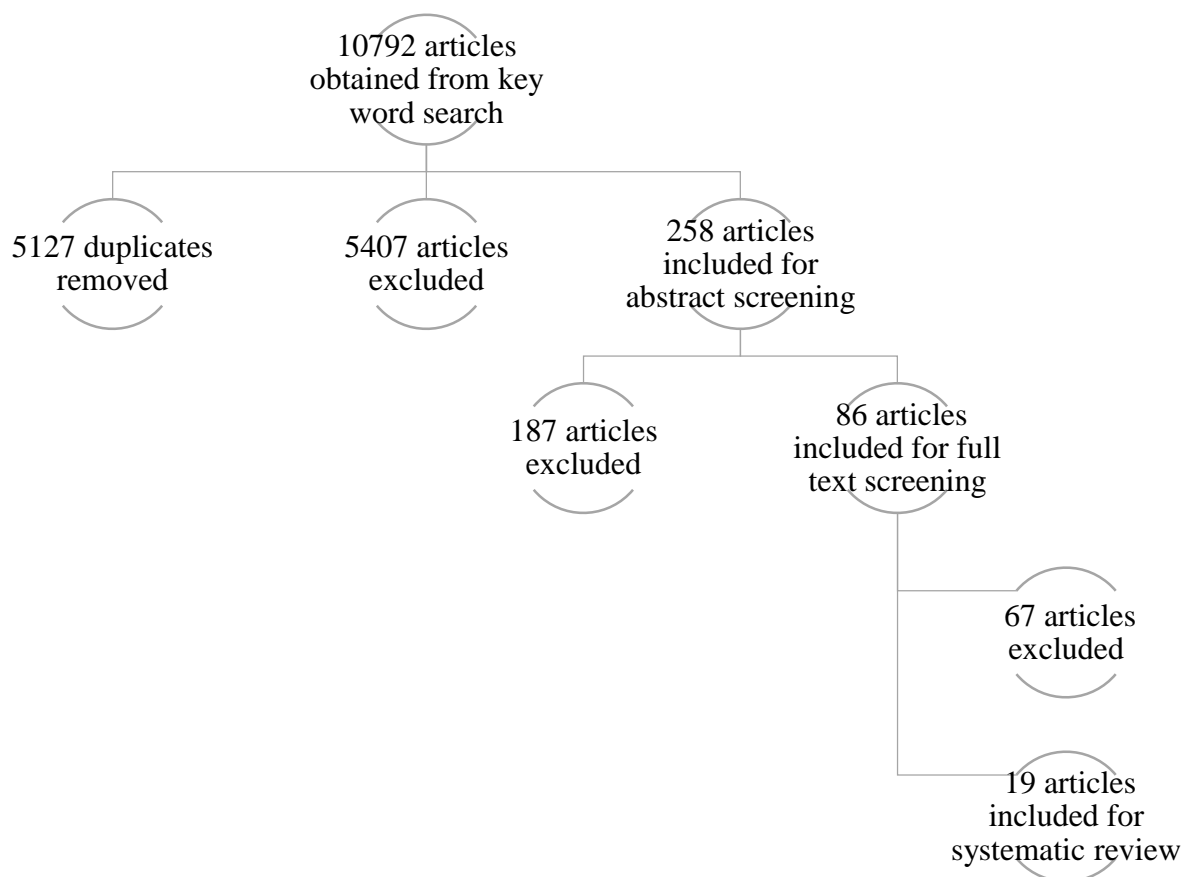


Figure 1: Number of results obtained, how the results were narrowed down and the number of studies that were included.

Nature of studies

Studies included randomized control trials (n=13, 68.4%), observational (n=3, 15.8%), and non-randomized control trials (n=3, 15.8%) using qualitative, quantitative, or mixed methods in design (table 2) with sample sizes ranging from 5 to 6841 participants. Participants included caregivers of children under 5 years old from diverse cultural and economic backgrounds. The majority of these studies were carried out in higher income countries (n=15; 79%), including the United States (n=12; 63.2%), Australia (n=2; 10.5%) and Puerto Rico (n=1; 5.3%). Very few of these studies were conducted in low (n=1; 5.3%) and middle (n=4; 21.05%) income countries.

Content of text messages

Message content included educational information regarding health and development (89.5%), reminders (i.e. for timely immunizations, attending antenatal care appointments, and oral health behaviors) (36.8%) and caregiver support (52.6%). The majority of studies (n=12; 63.2%) looked exclusively at text messaging. Others used a combination of text messages and educational documents (10.5%, n=2), text messages and phone calls (5.3%, n=1), text message and a face-to-face visit (5.3%, n=1), and a text message combined with both an educational document and a face-to-face visit (5.3%, n=1). Two studies (10.5%, n=2) made use of a two-way text messaging system which allowed caregivers to ask questions or give feedback.

Intervention Effectiveness

Given the range of outcomes that were assessed and the variety of study designs, a meta-analysis of study findings was not undertaken. According to a thematic analysis, two main themes (i.e. health and development) and nine sub-themes were identified (table 2). The majority of the studies (n=17; 89.5%) found statistically significant positive effects of text

message intervention on caregiver behavior. Text messages also had an effect on child outcomes, with 15.8% (n=3) of studies reporting a positive effect.

Table 3.2: Summary of identified categories and themes

Message Theme	n	%
Health	17	89.5
Development	2	10.5
Message sub-themes		
Health		
- Feeding practices (breastfeeding and complimentary feeding)	4	21.1
- PMTCT of HIV	2	10.5
- Health care utilization and emergency department visits	2	10.5
- Adherence with recommended vaccinations	4	21.1
- Weight management and decreasing sedentary lifestyle behavior	4	21.1
- Adherence to recommended maternal and infant healthcare visits	3	15.8
- Oral health knowledge and behavior	2	10.5
Development		
- Developmentally appropriate learning activities	1	5.3
- Speech and language development	1	5.3
Message outcome		
Caregiver behaviour change	18	94.7
Health and/or developmental outcomes	5	26.3

Health

Seventeen (89.47%) of the studies focused on the effect of a text messaging intervention regarding health. Sixteen (84.2%) articles demonstrated statistically significant positive changes in caregiver behaviour following a text message intervention. Five studies (26.3%) reported on the effectiveness of the intervention on child and/or maternal outcomes. Some studies (n=2; 10.5%), however, found insignificant effects of a text messaging intervention on caregiver behaviour change or child health outcomes (table 3).

Table 3.3: Statistical significance of text message intervention on caregiver behaviour change and child health outcomes

Article	Impact of text message intervention	Country	Significance
Maternal and child outcomes			
(Lund et al., 2014)	Increase in caregivers seeking and receiving preventive health services with more women with antepartum complications identified and referred	Tanzania	p<0.05 *
(Hannan et al., 2016)	Fewer infant morbidities, decreased emergency health care utilization, and considerably lower health care costs	USA	p<0.05*
(Downing et al., 2018; Haines et al., 2013)	Increasing children's sleep duration and reducing children's screen time	Australia	p<0.04*
(Haines et al., 2013)	Decreasing children's Body Mass Index (BMI)	USA	p<0.05*
(Kassaye et al., 2016)	Prevention of mother-to-child transmission (PMTCT)	Kenya	p>0.05 **

(Palacios et al., 2018)	No significant effects on feeding practices or weight	Puerto Rico and Hawaii	p=0.666**
Changes in caregiver behavior			
(Gallegos et al., 2014; Patel et al., 2018)	Increase in exclusive breastfeeding rates	Australia and India	p<0.05 *
(Brown et al., 2014)	Increased self-reported breastfeeding success	USA	p<0.05 *
(Brown et al., 2014; Bushar et al., 2017; Hannan et al., 2016; Jordan et al., 2015)	Increase in adherence with the recommended vaccinations	USA	p<0.05 *
(Brown et al., 2014; Hannan et al., 2016; Lund et al., 2014)	Improved adherence with recommended maternal and infant healthcare visits	USA and Tanzania	P<0.05 *
(Hashemian et al., 2014; Sharma et al., 2011)	General oral health knowledge, attitudes and practices including flossing behaviour and mouth rinsing	USA, India	P=0.01 *
(Hashemian et al., 2014)	Decrease in children's sugary food and drink intake	USA	P=0.05 *
(Odeny et al., 2014)	Increase in post-partum retention in PMTCT; increase in the rate of infant virological HIV testing	Kenya	P<0.05 *
(Ladley et al., 2018)	Reduced prevalence of non-urgent emergency department visits	USA	P<0.05 *

(Brown et al., 2019; Militello et al., 2016)	Increase in healthy lifestyle behaviors of parents of overweight preschoolers	USA	p<0.05 *
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* Significant effect ($p < 0.05$)

** No significant effect ($p > 0.05$)

Development

Two studies (10.5%) reported statistically significant positive changes in caregiver behaviour in regards to development. However, none of these studies reported on child outcomes (see table 4).

Table 3.4: Statistical significance of text message intervention on caregiver behaviour change regarding development.

Article	Impact of text message intervention on:	Country	Statistical significance
(Hurwitz et al., 2015)	Increased caregiver engagement in a range of developmentally appropriate learning activities with their young children	USA	p=0.019 *
(Olson et al., 2016)	Another study reported that a text messaging intervention enabled parents to positively change their child's linguistic environment	USA	p=0.004 *

*significant effect ($p < 0.05$)

** No significant effect ($p > 0.05$)

Discussion

A majority of studies (n=13; 68.4%) were randomised controlled trials reporting a high quality of evidence (Robey, 2004). These studies were predominantly addressing the topic of health (n=17; 89.5%). Articles related to development (n=5; 26.3%) were of lower-quality evidence as they were mostly observational studies. No concerns related to publication or selection bias were noted in and across the selected studies.

Evidence demonstrates text messaging to be a feasible, acceptable and a highly valued channel for delivering parenting information (Brown, Hudson, Campbell-Grossman, & Yates, 2014; Hurwitz, Lauricella, Hanson, Raden, & Wartella, 2015; Olson, Wilkinson, Wilkinson, Harris, & Whittle, 2016). However, many studies (n=15; 79%) reported on outcomes in higher income countries. Lower income countries face the major burden of barriers such as, low literacy, poor infrastructure, a lack of skilled professionals as well as cultural differences interfering with the adoption of a text messaging intervention (Latif et al., 2017). The underrepresentation of studies from LMICs (n=5; 26.3%) may be due to limited funding as well as the perceived public health importance compared to life-threatening conditions such as HIV/AIDS. It is important to consider the populations from a lower income setting as they may be more vulnerable to health and developmental issues and may face different challenges to high income countries. The potential impact of text messaging interventions may therefore be significantly more pervasive in LMICs.

Due to the diversity amongst content of messages within text message interventions, it is difficult to report on which type of SMS content was more effective. However, similar studies reported SMS interventions used as reminder systems to be more effective for topics related to immunizations (Domek, Contreras-Roldan, Asturias, Bronsert, Bolaños, O'Leary, . . . Bull, 2018) or frequent activities such as oral health behaviors, appointment reminders (Guy,

Hocking, Wand, Stott, Ali, & Kaldor, 2012), and medication adherence (Grange, Lewis, & Rockwern, 2012).

Text messages are less intrusive as they can be viewed whenever the caregiver has time (Sharma, Hebbal, Ankola, & Murugabupathy, 2011). It is vitally important that the message content and frequency of messages is sufficient to address caregiver concerns (Jordan, Bushar, Kendrick, Johnson, & Wang, 2015). Interventions that allowed a two-way interaction (n=2; 10.5%) for caregivers to respond to texts or to ask further questions provides an opportunity to identify specific and personal needs (Odeny et al., 2014). Studies also highlighted that although caregivers may already have the knowledge, text messages served as a reminder and encouragement and reinforcement in order to promote action change their behaviour (Brown et al., 2019; Hashemian, Kritz-Silverstein, & Baker, 2014; Sharma et al., 2011).

An interesting finding suggested that the option of a voice message rather than a text-message may be an important consideration in overcoming literacy barriers (Lund et al., 2014; Sharma et al., 2011). Studies also reported evidence of shared mobile phone ownership within households (Lund et al., 2014). This suggests that caregivers within the household who do not have their own registered phone would still have access to the information provided in the message. Studies also highlighted that caregivers frequently showed or forwarded the SMS to someone else (i.e. neighbors, relatives, friends and colleagues) (Nayoan, 2017).

There is a potential limitation of technology based communication systems at delivering health related information, which does not account for the structural barriers faced by caregivers in seeking facility-based interventions (Hannan, Brooten, Page, Galindo, & Torres, 2016; Kassaye et al., 2016; Odeny et al., 2014). However, another interesting finding suggested that by creating awareness for caregivers and highlighting the demand for service delivery from the

government, mobile phone interventions may result in improved quality of care for children and families (Lund et al., 2014).

Health

Delivery of health information via SMS resulted in improvements in oral health behaviour (n=2; 10.5%), feeding practices (n=3; %), adherence to recommended vaccinations (n=4; 21.1%) (Jordan et al., 2015), antenatal care attendance (n=3; 15.8) (Lund et al., 2014) and improved effective, necessary utilization of emergency department visits (n=2; 10.5%) (Ladley, Hieger, Arthur, & Broom, 2018), breastfeeding and health-seeking behaviours.

Text interventions resulted in higher rates of exclusive breastfeeding and complimentary feeding practices ($p < 0.05$). Studies reported that this success can be credited to the frequency of support and counselling through this intervention (Brown et al., 2014; Gallegos, Russell-Bennett, Previte, & Parkinson, 2014; Patel et al., 2018). Gallegos et al. (2014) illustrates that all types of extra support will influence caregiver's feeding practices. There may be a considerable impact on behaviour change and outcomes if caregivers received more text messages for a longer period of time (Gallegos et al., 2014); however, this still needs to be investigated. Breastfeeding mothers benefitted from support-based text messages as social support in the first year of a child's life has been associated with parent stress levels (Hannan et al., 2016).

Rather than simply providing educational information, caregivers benefitted from receiving strategy suggestions to overcome barriers, achieve goals and assist with problem solving in making appropriate health related decisions for their children (Downing, Salmon, Hinkley, Hnatiuk, & Hesketh, 2018; Haines et al., 2013). Messages also encourage goal orientated, self-monitoring behaviours, resulting in better child health outcomes (Downing et al., 2018). It was found that caregivers did not make use of website links (to videos, further information, etc.)

within texts as they found messages to be substantial (Downing et al., 2018). This is an important observation as caregivers from LMICs may not have the means to access further information (due to a lack of internet access or the expense of data), and caregivers from higher income countries may lack the time.

Studies indicated that tailored public health interventions (tailored to the infant's age, language, preferred time, etc.) may be more efficacious for the prevention of mother-to-child transmission (PMTCT) than typical interventions (Odeny et al., 2014). Interventions targeting weight management and vaccination adherence also reported similar findings as personalising text messages influenced retention rates (Brown et al., 2019; Bushar, Kendrick, Ding, Black, & Greby, 2017). Many studies (n=17; 89.5%) emphasised the positive effect of multicomponent, individually tailored, positively framed text messages (adapted to cultural relevancy, frequency, schedule and utilization) in improved relevance to the user and achieving positive health and development outcomes and caregiver behaviour change (Bushar et al., 2017; Haines et al., 2013; Militello, Melnyk, Hekler, Small, & Jacobson, 2016).

Studies that did not report statistically significant effects on interventions were related to health interventions targeting caregiver behaviour; including PMTCT of HIV (n=1; 5.3%), feeding practices and weight management (n=1; 5.3%). Kassaye et al. (2016) recorded an insignificant impact of text messages in PMTCT, as there was similar improvement in both the intervention and the control groups. This may be due to the increased communication between the participants and community health workers (even though the control group did not receive SMSs) (Kassaye et al., 2016). Increased communication may result in increased health seeking behaviours (Lund et al., 2014).

The effects of the SMS intervention on feeding practices may not have yielded desired results due to the limited time period of the intervention. It has also been suggested that feeding

interventions are more successful with an increase in message frequency; when coupled with home visits and counselling sessions; when other caregivers are included in the intervention (Palacios et al., 2018). Other studies such as (Jiang et al., 2014) demonstrated positive effects of feeding intervention programs when initiated earlier during pregnancy to successfully impact caregiver decision making about early feeding practices.

Development

There was a lack of studies on the topic of development. This may be due to the perceived public concern of health over development. However, reported text messaging interventions targeting developmental outcomes such as developmentally appropriate learning activities (n=1; 5.3%) and speech and language development (n=1; 5.3%) demonstrated positive results. Parents reported that activity suggestions were particularly helpful (Hurwitz et al., 2015). Hurwitz et al. (2015) reported that a SMS intervention providing not only skills training, but also positive messages related to the strengths of a father's parenting role, resulted in higher rates of responsiveness. This study also highlighted that interventions targeting developmentally appropriate learning activities may be more beneficial for parents of boys as they may have a greater need for activity suggestions (Hurwitz et al., 2015).

Text message interventions may also be particularly beneficial for speech and language development in young children as there are time constraints and possible language barriers that may cause limitations within clinical settings. Text messages allow for generalizability from a clinical setting to their everyday environment as parents can act immediately on information and suggestions as well as store the messages for future reference (Olson et al., 2016).

Limitations and strengths

Frequently mentioned limitations within studies included (1) the lack of generalization as sample groups were frequently homogenous (e.g. from the same income group category, only

mothers as caregivers, small sample size etc.); (2) self-reported parental outcomes rather than objective measures; thus parents may have exaggerated improvements in behaviours or outcomes); (3) due to the nature of a text messaging intervention, blinding of participants was difficult; (4) Sustained impact as long-term behaviour changes were not evaluated. Misunderstanding or misinterpretations of messages, data protection, and maintaining confidentiality may also need to be considered as limitations (Sharma et al., 2011).

There were also limitations related to this systematic review. Due to the limited number of articles that were acquired, there may be a lack of generalizability of results. Due to inclusion of other elements of information delivery (i.e. not only a SMS element), it may be difficult to differentiate between different elements that contributed to the intervention's effectiveness. Secondly, as the majority of these studies were based on higher income countries, it may be difficult to generalize outcomes to all LMIC's.

Implications

Future research should examine whether intervention programs affect objective measures of children's health and developmental outcomes rather than simply targeting caregivers' behaviour change. It is vital to determine if caregiver behaviour change is resulting in improved child outcomes. Results indicate that implementing a text message intervention more broadly may result in significant health care cost savings (Hannan et al., 2016). Findings from this study are important for influencing governmental policy as investing in the health and development of children, governments will be investing in the future generation.

Conclusion

Current evidence from this review supports text messaging as an effective tool to change caregiver behaviour and child outcomes across a range of health and to a more limited extent in development. Development had limited quantity and quality of evidence and requires more

studies. Overall findings indicate improved caregiver comfort with fundamental infant health and development decisions, which may be attributable to constant, small quantities of information received via text message from health care professionals (Ladley et al., 2018). Most studies were conducted in higher income countries, which necessitates more research to be done in LMICs.

Declaration of interest statement

The authors are accountable for the content and writing of the paper.

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Chapter 4: Discussion and Conclusion

Chapter Aim:

The aim of this chapter is to discuss the implications of the research findings, to describe the strengths and limitations of the study, to identify the need for further research and to draw a final conclusion.

4.1 Discussion of results

This review's findings emphasise the positive effect of multicomponent, individually tailored, positively framed text messages (adapted to cultural relevancy, frequency, schedule and utilization) in achieving positive outcomes (Bushar et al., 2017; Haines et al., 2013; Militello et al., 2016). These results suggest that caregivers felt more comfortable with basic infant health care decisions, which may be attributable to continuous, small doses of information received via text message from health care professionals (Ladley et al., 2018). Rather than simply providing educational information, caregivers benefitted from receiving strategy suggestions to overcome barriers, achieve goals and assist with problem solving (Downing et al., 2018; Haines et al., 2013). It was found that caregivers did not make use of website links (such as videos or further information) within texts as they found the messages to be substantial (Downing et al., 2018). This is an important observation as caregivers from lower income countries may not have the means to access further information (as they may lack internet access or mobile data to view alternate sources if information) and caregivers from higher income countries may lack sufficient time to view alternate sources.

Table 2 below provides a brief overview of the research study results. This table summarizes the countries where text messaging interventions were conducted, the level of evidence within the identified studies, themes and sub-themes that were identified, message content, the method of messaging, as well as the targeted outcomes of the intervention.

Table 4.1: Summary of results

Study characteristics	No. of studies (n=19)	Percentage of studies (%)
<i>COUNTRY</i>		
USA	12	63.2
Australia	2	10.5
Kenya	2	10.5
Puerto Rico	1	5.3
India	2	10.5
Tanzania	1	5.3
<i>LEVEL OF EVIDENCE (According Robey, 2004)</i>		
Randomised control trials	13	68.4
Non-randomized controlled trial (quasi-experiments)	3	15.8
Observational studies with controls (retrospective studies, interrupted time-series studies, case-control studies, cohort studies with controls)	0	0
Observational studies without controls (cohort studies without controls and case series)	3	15.8
MESSAGE CHARACTERISTICS		
<i>MESSAGE THEMES</i>		
Feeding practices (breastfeeding and complimentary feeding)	4	21.1
Prevention of mother-to-child transmission (PMTCT) of HIV	2	10.5
Health care utilization and emergency department visits	2	10.5
Adherence with recommended vaccinations	4	21.1
Weight management and decreasing sedentary lifestyle behaviour	4	21.1
Adherence with recommended maternal and infant healthcare visits	3	15.8
Oral health knowledge and behaviour	2	10.5
Developmentally appropriate learning activities	1	5.3
Speech and language development	1	5.3
<i>MESSAGE CONTENT</i>		
Reminders	7	36.8
Educational information	17	89.5
Support	10	52.6
<i>METHOD OF MESSAGING</i>		
Text message	12	63.2
Two-way text messaging	2	10.5
Text message + other information documents	2	10.5
Text message + phone call	1	5.3
Text message + face to face visit	1	5.3
Text message + visit + documents	1	5.3
<i>TARGETED MESSAGE OUTCOME</i>		
Caregiver behaviour change	18	94.7
Health and developmental outcomes	5	26.3
<i>MESSAGE CATEGORY</i>		
Health	17	89.5
Development	2	10.5

4.2 Clinical and theoretical implications

Studies indicated text messaging to be a feasible, acceptable and a highly valued channel for delivering parenting information (S. Brown et al., 2014; Hurwitz et al., 2015; Olson et al., 2016). Text messages are viewed as less intrusive as they can be viewed whenever the caregivers have time (Sharma et al., 2011). However, a lack of research on the topic of development exists.

Governing bodies need to focus on improving caregiver health and developmental literacy as this may result in improved outcomes in children (Hall et al., 2015). Using a text messaging system allows educational information to be more accessible for caregivers. This can be written in as part of service delivery in policy documents and may also assist health professionals to effectively meet the demand for services with the use of prevention and early identification techniques, rather than treatment (Slemming & Saloojee, 2013). Both health and development outcomes should be carefully considered when addressing the content of text messages. If policy makers understand the integrated effect of health and development outcomes, children at risk due to various health concerns will also be supported in ECD.

Text messages allow for generalizability from a clinical setting to everyday environments as parents can act immediately on information and suggestions as well as store the messages for future reference (Olson et al., 2016). An interesting finding recommended that the option of a voice message rather than a text-message may be an important consideration in overcoming literacy barriers (Lund et al., 2014; Sharma et al., 2011). Studies also reported evidence of heterogeneous mobile phone ownership, suggesting that the SMS content would reach more caregivers without their own registered phone numbers (Lund et al., 2014). Caregivers also frequently showed or forwarded the SMS to someone else, such as neighbours, relatives, friends and colleagues (Nayoan, 2017).

The results of these studies suggest that significant health care cost savings could be achieved by implementing this type of intervention more broadly (Hannan et al., 2016). Findings from this study are important for influencing governmental policy on ECD as investing in the health and development of young children will be investing in the future generation and increase awareness.

4.3 Critical evaluation and recommendations

This study has strengths and limitations. This systematic review was conducted according to the PRISMA-P guidelines which is deemed a valid and reliable research methodology protocol (Shamseer et al., 2015).

The use of this protocols enables:

- the interpretation and evaluation of the review method,
- the identification and adjustment to methods,
- identification of selective reporting,
- the preparation and reporting of research findings,
- peer reviewers and editors to determine the completeness and clarity of the research article submitted for publication (Shamseer et al., 2015).

According to Robey (2004), a systematic review is the highest quality of evidence. There are several strengths specifically related to systematic reviews present in this study including: a clearly stated objective; clearly stated inclusion and exclusion criteria; multiple databases were searched; the study selection was described in detail; a list of both included and excluded studies has been provided; a thorough summary of included studies, risk of bias and the level of evidence was assessed; characteristics of individual studies were provided; and there are no conflicts of interest present.

There are also limitations to this study as a meta-analysis could not be conducted. A meta-analysis is a statistical method that is often conducted with systematic reviews. It is used to improve statistical power, evaluate the size of the effect, and/or to clarify uncertainty when reports disagree. Without a meta-analysis, generalizability of results of this study may be difficult.

This study highlights the potential for successful implementation of text based mHealth intervention in various communities. Future research should continue to explore the use of technology (specifically text messaging) as a means of information distribution, prevention and early detection. LMICs need to explore the use of technology as they may be more vulnerable to health and developmental issues. Further research may need to address the effects of potential misunderstanding or misinterpretations of messages, data protection, and maintaining (Sharma et al., 2011). Research should

also examine whether intervention programs influence child's health and developmental outcomes rather than simply targeting caregiver behaviour change.

4.4 Conclusion

Current evidence summarised from this review supports text messaging as an effective tool to change caregiver behaviour and child outcomes across a range of health and ECD related topics. The findings suggest increased caregiver comfort with basic infant health and development decisions, which may be attributable to continuous, small doses of information received via text message from health care professionals (Ladley et al., 2018). Development has more limited quantity and quality of evidence and future research is therefore recommended especially in LMICs.

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Appendices

Appendix A: Ethical Approval Letter from the Research Ethics Committee



1 March 2019

Dear Miss BP Richardson

Project Title: The effect of targeted text messaging as a health and development education tool for caregivers of babies and young children: A systematic review
Researcher: Miss BP Richardson
Supervisor: Dr J Van der Linde
Department: Speech Language Path and Aud
Reference number: HUM009/0219
Degree: Masters

Thank you for the application that was submitted for ethical consideration.

The Research Ethics Committee notes that this is a literature-based study and no human subjects are involved.

The application has been approved on 28 February 2019 with the assumption that the document(s) are in the public domain. Data collection may therefore commence, along these guidelines.

Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal. However, should the actual research depart significantly from the proposed research, a new research proposal and application for ethical clearance will have to be submitted for approval.

We wish you success with the project.

Sincerely

A handwritten signature in black ink, appearing to read 'Maxi Schoeman'.

Prof Maxi Schoeman
Deputy Dean: Postgraduate Studies and Ethics
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail:PGHumanities@up.ac.za

Appendix B: Reasons for article exclusion

ARTICLE	REASON FOR EXCLUSION
<p>Cunningham, M., Bull, S., McNulty, M. C., Colborn, K., Chavez, C., Berman, S., ... Allison, M. A. (2018). Does a text-messaging program to promote early childhood development reach the highest risk families? <i>MHealth</i>, 4(October), 55–55. https://doi.org/10.21037/mhealth.2018.11.03</p>	<p>No outcome</p>
<p>Laar, A. S., Bekyieriya, E., Isang, S., & Baguune, B. (2019). Assessment of mobile health technology for maternal and child health services in rural Upper West Region of Ghana. <i>Public Health</i>, 168, 1–8. https://doi.org/10.1016/j.puhe.2018.11.014</p>	<p>Study reported on mothers' acceptability, willingness to receive more info, challenges, etc.)</p>
<p>Parker, R. M., Dmitrieva, E., Frolov, S., & Gazmararian, J. A. (2012). Text4baby in the United States and Russia: An opportunity for understanding how mHealth affects maternal and child health. <i>Journal of Health Communication</i>, 17, 30–36. https://doi.org/10.1080/10810730.2011.649162</p>	<p>Informative article with no pre-post-test study design</p>
<p>Skinner, D., Delobelle, P., Pappin, M., Pieterse, D., Esterhuizen, T. M., Barron, P., & Dudley, L. (2018). User assessments and the use of information from MomConnect, a mobile phone text-based information service, by pregnant women and new mothers in South Africa. <i>BMJ Global Health</i>, 3, e000561. https://doi.org/10.1136/bmjgh-2017-000561</p>	<p>Qualitative study design (mothers evaluation of system, role and impact)</p>
<p>Ahlers-Schmidt, C. R., Chesser, A., Brannon, J., Lopez, V., & Shah-Haque, S. (2013). Necesita Una Vacuna : What Spanish- Speakers Want. <i>Journal of Health Care for the Poor and Underserved</i>, 24(3), 1031–1041.</p>	<p>Study results not related to behaviour change or child outcomes (parent preferences for content of messages)</p>
<p>Ahlers-Schmidt, C. R., Hart, T., Chesser, A., Williams, K. S., Yaghmai, B., Shah-Haque, S., & Wittler, R. R. (2012). Using human factors techniques to design text message reminders for childhood immunization. <i>Health Education and Behavior</i>, 39(5), 538–543. https://doi.org/10.1177/1090198111420866</p>	<p>Study reported on levels of comprehension and intention to act on messages</p>
<p>Carlin, R. F., Abrams, A., Mathews, A., Joyner, B. L., Oden, R., McCarter, R., & Moon, R. Y. (2018). The Impact of Health Messages on Maternal Decisions About Infant Sleep Position: A Randomized Controlled Trial. <i>Journal of Community Health</i>, 43(5), 977–985. https://doi.org/10.1007/s10900-018-0514-0</p>	<p>General health messages (not a text messaging system)</p>

<p>Hofstetter, A. M., Vargas, C. Y., Kennedy, A., Kitayama, K., & Stockwell, M. S. (2013). Parental and provider preferences and concerns regarding text message reminder/recall for early childhood vaccinations. <i>Preventive Medicine</i>, 57(2), 75–80. https://doi.org/10.1016/j.ypmed.2013.04.007</p>	<p>Article reports on parents' concerns and need for support</p>
<p>Monte, C. M. G., Ashworth, A., Nations, M. K., Lima, A. A., Barreto, A., & Huttly, S. R. A. (1997). Designing educational messages to improve weaning food hygiene practices of families living in poverty. <i>Social Science and Medicine</i>, 44(10), 1453–1464. https://doi.org/10.1016/S0277-9536(96)00241-9</p>	<p>Not a text messaging system (general health education program)</p>
<p>Mwapasa, V., Joseph, J., Tchereni, T., Jousset, A., & Gunda, A. (2017). Impact of mother-infant pair clinics and short-text messaging service (SMS) reminders on retention of HIV-infected women and HIV-exposed infants in eMTCT care in Malawi: A cluster randomized trial. <i>Journal of Acquired Immune Deficiency Syndromes</i>, 75, S123–S131. https://doi.org/10.1097/QAI.0000000000001340</p>	<p>Only a reminder SMS system element of one study arm (reminder is sent to community based volunteer, not the caregiver)</p>
<p>Nyström, C. D., Sandin, S., Henriksson, P., Henriksson, H., Trolle-Lagerros, Y., Larsson, C., ... Löf, M. (2017). Mobile-based intervention intended to stop obesity in preschool-aged children: The MINISTOP randomized controlled trial. <i>American Journal of Clinical Nutrition</i>, 105(6), 1327–1335. https://doi.org/10.3945/ajcn.116.150995</p>	<p>Intervention delivered via a smart-phone application</p>
<p>Phillips, J. H., Wigger, C., Beissbarth, J., McCallum, G. B., Leach, A., & Morris, P. S. (2014). Can mobile phone multimedia messages and text messages improve clinic attendance for Aboriginal children with chronic otitis media? A randomised controlled trial. <i>Journal of Paediatrics and Child Health</i>, 50(5), 362–367. https://doi.org/10.1111/jpc.12496</p>	<p>MMS system; children up to age of 13 years</p>
<p>Ronen, K., Unger, J. A., Drake, A. L., Akinyi, P., Osborn, L., Matemo, D., ... John-stewart, G. (2018). SMS messaging to improve ART adherence: perspectives of pregnant HIV-infected women in Kenya on HIV-related message content. <i>AIDS Care</i>, 30(4), 500–505. https://doi.org/10.1080/09540121.2017.1417971.SMS</p>	<p>Outcomes related to mothers' preference for contact and disclosure of HIV status (not a related to caregiver behaviour or child outcomes)</p>
<p>Sutcliffe, C. G., Thuma, P. E., van Dijk, J. H., Sinywimaanzi, K., Mweetwa, S., Hamahuwa, M., & Moss, W. J. (2017). Use of mobile phones and text messaging to decrease the turnaround time for early infant HIV diagnosis and notification in</p>	<p>Tests results sent to caregivers via SMS (not educational messaging or reminders)</p>

rural Zambia: An observational study. <i>BMC Pediatrics</i> , 17, 66. https://doi.org/10.1186/s12887-017-0822-z	
Ahsan, A., & Raihan, A. (2013). Understanding mhealth impact among Aponjon (MAMA Bangladesh) subscribers through a phone survey in Bangladesh. <i>ACM International Conference Proceeding Series</i> , 1–4. https://doi.org/10.1145/2517899.2517920	Conference paper
Alam, M., D 'este, C., Banwell, C., & Lokuge, K. (2017). The impact of mobile phone based messages on maternal and child healthcare behaviour: a retrospective cross-sectional survey in Bangladesh. <i>BMC Health Services Research</i> , 17, 434. https://doi.org/10.1186/s12913-017-2361-6	Cross sectional study (no pre and post-test)
Awiti, P. O., Grotta, A., Van Der Kop, M., Dusabe, J., Thorson, A., Mwangi, J., ... Ekström, A. M. (2016). The effect of an interactive weekly mobile phone messaging on retention in prevention of mother to child transmission (PMTCT) of HIV program: Study protocol for a randomized controlled trial (WELTEL PMTCT). <i>BMC Medical Informatics and Decision Making</i> , 16(1), 86. https://doi.org/10.1186/s12911-016-0321-4	Use of SMS is not in line with the specified inclusion criteria
Basu, S., Garg, S., Kumar, R., & Shukla, A. (2017). The willingness for using mobile phone for health education among women caregivers of under 5 children in an urban resettlement colony in Delhi, India. <i>Indian Journal of Community Health</i> , 29(4), 439–444.	Cross sectional study (the article does not report on the outcome of an SMS intervention)
Brar, M. S., & Cariappa, M. P. (2014). Exploring the use of mobile phone technology for the enhancement of the prevention of mother-to-child transmission of HIV program in Nyanza, Kenya: A qualitative study. <i>Medical Journal Armed Forces India</i> , 70(3), 1131. https://doi.org/10.1016/j.mjafi.2014.06.010	Qualitative study (no pre and post test data)
Brinkel, J., May, J., Krumkamp, R., Lamshöft, M., Kreuels, B., Owusu-Dabo, E., ... Fobil, J. N. (2017). Mobile phone-based interactive voice response as a tool for improving access to healthcare in remote areas in Ghana – an evaluation of user experiences. <i>Tropical Medicine and International Health</i> , 22(5), 622–630. https://doi.org/10.1111/tmi.12864	Not an SMS intervention (article only reports on barriers to acceptance)
Bruun, S., Buhl, S., Husby, S., Jacobsen, L. N., Michaelsen, K. F., Sørensen, J., & Zachariassen, G. (2017). Breastfeeding, infant formula, and introduction to complementary foods - comparing data obtained by questionnaires and health visitors' reports to weekly short message service text messages.	Text message are used as data collection (the use of SMS is not in line with the specified inclusion criteria)

<p><i>Breastfeeding Medicine</i>, 12(9), 554–560. https://doi.org/10.1089/bfm.2017.0054</p>	
<p>Burn, E., Marshall, A. L., Miller, Y. D., Barnett, A. G., Fjeldsoe, B. S., & Graves, N. (2015). The cost-effectiveness of the MobileMums intervention to increase physical activity among mothers with young children: A Markov model informed by a randomised controlled trial. <i>BMJ Open</i>, 5(4), e007226. https://doi.org/10.1136/bmjopen-2014-007226</p>	<p>Reported outcomes are not relevant to specified inclusion criteria (i.e. cost effectiveness)</p>
<p>Bushar, J. A., Fishman, J., Garfinkel, D., & Pirretti, A. (2019). Enrolling underserved women in mHealth programs: Results from Text4baby outreach campaigns. <i>Health Promotion Practice</i>, 20(2), 292–299. https://doi.org/10.1177/1524839918763589</p>	<p>Outcomes are not related to specified inclusion criteria (enrolment rates and factors that may influence enrolment)</p>
<p>Chai, L. K., May, C., Collins, C. E., & Burrows, T. L. (2018). Development of text messages targeting healthy eating for children in the context of parenting partnerships. <i>Nutrition and Dietetics</i>, 1–6. https://doi.org/10.1111/1747-0080.12498</p>	<p>No outcome</p>
<p>Cormick, G., Kim, N. A., Rodgers, A., Gibbons, L., Buekens, P. M., Belizán, J. M., & Althabe, F. (2012). Interest of pregnant women in the use of SMS (short message service) text messages for the improvement of perinatal and postnatal care. <i>Reproductive Health</i>, 9, 9. https://doi.org/10.1186/1742-4755-9-9</p>	<p>Outcomes are not related to specified inclusion criteria (access and usage of cell phones and health information as well as the needs of mothers)</p>
<p>Dean, A. L., Makin, J. D., Kydd, A. S., Biriotti, M., & Forsyth, B. W. C. (2012). A pilot study using interactive SMS support groups to prevent mother-to-child HIV transmission in South Africa. <i>Journal of Telemedicine and Telecare</i>, 18(7), 399–403. https://doi.org/10.1258/jtt.2012.120118</p>	<p>The use of SMS is not in line with the specified inclusion criteria (Group SMS)</p>
<p>Drake, A. L., Unger, J. A., Ronen, K., Matemo, D., Perrier, T., DeRenzi, B., ... John-Stewart, G. (2017). Evaluation of mHealth strategies to optimize adherence and efficacy of option B+ prevention of mother-to-child HIV transmission: Rationale, design and methods of a 3-armed randomized controlled trial. <i>Contemporary Clinical Trials</i>, 57(2017), 44–50. https://doi.org/10.1016/j.cct.2017.03.007</p>	<p>No conclusion (study protocol)</p>
<p>Duan V; Jia Weijun; Pang X; Bi Y; Wang J; Yin S; Yang Z. (2016). Effects of text message intervention on infant growth and anemia at 6 month old. <i>Wei Sheng Yan Jiu</i>, 45(2), 226–235.</p>	<p>No English translation of the article available</p>

<p>Fairbanks, J., Beima-Sofie, K., Akinyi, P., Matemo, D., Unger, J. A., Kinuthia, J., ... Ronen, K. (2018). You will know that despite being HIV positive you are not alone: Qualitative study to inform content of a text messaging intervention to improve prevention of mother-to-child HIV transmission. <i>JMIR MHealth and UHealth</i>, 6(7), e10671. https://doi.org/10.2196/10671</p>	<p>Article reported on SMS content preferences – no reported outcomes of the text message intervention</p>
<p>Fletcher, R., May, C., Attia, J., Garfield, C. F., & Skinner, G. (2018). Text-based program addressing the mental health of soon-to-be and new fathers (SMS4dads): Protocol for a randomized controlled trial. <i>Journal of Medical Internet Research</i>, 20(2), 1–8. https://doi.org/10.2196/resprot.8368</p>	<p>Smart phone required (includes links to web pages)</p>
<p>Fletcher, R., May, C., Lambkin, F. K., Gemmill, A. W., Cann, W., Nicholson, J. M., ... Skinner, G. (2017). Sms4dads: Providing information and support to new fathers through mobile phones - A pilot study. <i>Advances in Mental Health</i>, 15(2), 121–131. https://doi.org/10.1080/18387357.2016.1245586</p>	<p>Participants required to have smartphone; the study states that the "aim of the paper is to inform development of a system..."</p>
<p>Githinji, S., Jones, C., Malinga, J., Snow, R. W., Talisuna, A., & Zurovac, D. (2015). Development of a text-messaging intervention to improve treatment adherence and post-treatment review of children with uncomplicated malaria in western Kenya. <i>Malaria Journal</i>, 14(1), 1–9. https://doi.org/10.1186/s12936-015-0825-x</p>	<p>Reminders with no supportive or educational content</p>
<p>Grutzmacher, S. K., Braunscheidel Duru, E., Speirs, K. E., Worthington, L., Munger, A. L., & Lachenmayr, L. A. (2018). Using text messages to engage low-income parents in school-based nutrition education. <i>Journal of Hunger and Environmental Nutrition</i>, 13(3), 335–339. https://doi.org/10.1080/19320248.2017.1364196</p>	<p>Unspecified age range of children</p>
<p>Harari, N., Rosenthal, M. S., Bozzi, V., Goeschel, L., Jayewickreme, T., Onyebeke, C., ... Perez-Escamilla, R. (2018). Feasibility and acceptability of a text message intervention used as an adjunct tool by WIC breastfeeding peer counsellors: The LATCH pilot. <i>Maternal and Child Nutrition</i>, 14, e12488. https://doi.org/10.1111/mcn.12488</p>	<p>Feasibility study (engagement and mother's satisfaction with texting platform)</p>
<p>Huang, S., & Li, M. (2017). Piloting a mHealth intervention to improve newborn care awareness among rural Cambodian mothers: A feasibility study. <i>BMC Pregnancy and Childbirth</i>, 17, 356. https://doi.org/10.1186/s12884-017-1541-z</p>	<p>Acceptability and feasibility study (outcomes are unrelated to inclusion criteria)</p>

<p>Jennings L, Ongech J, Simiyu R, Sirengo M, K. S. (2014). Exploring the use of mobile phone technology for the enhancement of the prevention of mother-to-child transmission of HIV program in Nyanza, Kenya: A qualitative study. <i>Medical Journal Armed Forces India</i>, 70, 304. https://doi.org/10.1016/j.mjafi.2014.06.010</p>	<p>Qualitative study (no pre and post test data)</p>
<p>Jiang, H., Li, M., Wen, L. M., Baur, L. A., He, G., Ma, X., & Qian, X. (2018). A short message service intervention for improving infant feeding practices in Shanghai, China: Planning, implementation, and process evaluation. <i>JMIR MHealth and UHealth</i>, 6(10), e11039. https://doi.org/10.2196/11039</p>	<p>No outcome</p>
<p>Jiang, H., Li, M., Wen, L. M., Hu, Q., Yang, D., He, G., ... Qian, X. (2014). Effect of short message service on infant feeding practice findings from a community-based study in shanghai, china. <i>JAMA Pediatrics</i>, 168(5), 471–478. https://doi.org/10.1001/jamapediatrics.2014.58</p>	<p>Only the abstract is available. The abstract may have been published for a conference but the article was never published</p>
<p>Lavery AM; Nair U; Bass SB; Collins BN. (2016). The influence of health messaging source and frequency on maternal smoking and child exposure among low-income mothers. <i>Journal of Communication in Healthcare</i>, 9(3), 200–209. https://doi.org/doi: 10.1080/17538068.2016.1231858.</p>	<p>General health messages from various sources (not necessarily a text messaging system)</p>
<p>Marshall, A. L., Miller, Y. D., Graves, N., Barnett, A. G., & Fjeldsoe, B. S. (2013). Moving MobileMums forward: Protocol for a larger randomized controlled trial of an improved physical activity program for women with young children. <i>BMC Public Health</i>, 13, 5. https://doi.org/10.1186/1471-2458-13-593</p>	<p>Study protocol which reports on the "efficacy, feasibility and acceptability, cost-effectiveness, mediators and moderators"</p>
<p>Martin, E., Weiland, C., & Page, L. C. (2018). Text-based mentoring for postpartum mothers: a feasibility study. <i>Early Child Development and Care</i>. https://doi.org/10.1080/03004430.2018.1540984</p>	<p>Feasibility study (characteristics, engagement in program and acceptability of different group)</p>
<p>Maslowsky, J., Frost, S., Hendrick, C. E., Trujillo Cruz, F. O., & Merajver, S. D. (2016). Effects of postpartum mobile phone-based education on maternal and infant health in Ecuador. <i>International Journal of Gynecology and Obstetrics</i>, 134(1), 93–98. https://doi.org/10.1016/j.ijgo.2015.12.008</p>	<p>Not text messaging intervention (phone calls)</p>
<p>Mathews, A., Joyner, B. L., Oden, R. P., He, J., McCarter, R., & Moon, R. Y. (2016). Messaging affects the behavior of African American parents with regards to soft bedding in the infant sleep environment: A randomized controlled trial. <i>Journal of</i></p>	<p>Not a SMS intervention</p>

<p><i>Pediatrics</i>, 175, 79–85. https://doi.org/10.1016/j.jpeds.2016.05.004</p>	
<p>Mello, M. J., Gilbard, Z., Burstein, D., Baird, J., Zonfrillo, M. R., Flanagan, P., ... Howland, J. (2019). Formative research to underpin a text messaging home safety intervention for young mothers. <i>Health Education Journal</i>, 78(3), 266–272. https://doi.org/10.1177/0017896918799799</p>	Feasibility study
<p>Militello, L. K., Melnyk, B. M., Hekler, E., Small, L., & Jacobson, D. (2016). Correlates of healthy lifestyle beliefs and behaviors in parents of overweight or obese preschool children before and after a cognitive behavioral therapy intervention with text Messaging. <i>Journal of Pediatric Health Care</i>, 30(3), 252–260. https://doi.org/10.1016/j.pedhc.2015.08.002</p>	SMS reminder system with no education or supportive aspect (about caregiver attitude and beliefs)
<p>Mo, D., Luo, R., Liu, C., Zhang, H., Zhang, L., Medina, A., & Rozelle, S. (2014). Text messaging and its impacts on the health and education of the poor: Evidence from a field experiment in rural China. <i>World Development</i>, 64, 766–780. https://doi.org/10.1016/j.worlddev.2014.07.015</p>	Intervention not only used to target caregivers of young children
<p>Muro, C., & Mselle, L. J. (2014). Implementation of mobile-phone services in preventing mother-to-child transmission of hiv (PMTCT). <i>International Conference on IT Convergence and Security</i>, (March 2012), 1–4. https://doi.org/10.1109/ICITCS.2014.7021778</p>	Conference paper
<p>Mushamiri, I., Luo, C., Iiams-Hauser, C., & Ben Amor, Y. (2015). Evaluation of the impact of a mobile health system on adherence to antenatal and postnatal care and prevention of mother-to-child transmission of HIV programs in Kenya. <i>BMC Public Health</i>, 15, 1–16. https://doi.org/10.1186/s12889-015-1358-5</p>	Reminder based system
<p>Nachega, J. B., Skinner, D., Jennings, L., Magidson, J. F., Altice, F. L., Burke, J. G., ... Theron, G. B. (2016). Acceptability and feasibility of mHealth and community-based directly observed antiretroviral therapy to prevent mother-to-child HIV transmission in South African pregnant women under Option B+: An exploratory study. <i>Patient Preference and Adherence</i>, 10, 683–690. https://doi.org/10.2147/PPA.S100002</p>	No outcome
<p>Nayoan, C. R. (2017). Child health promotion using text messaging in Kupang Regency, East Nusa Tenggara, Indonesia. <i>Advanced Science Letters</i>, 23(4), 3497–3499. https://doi.org/10.1166/asl.2017.9146</p>	Unspecified age range and mentions the children "reading the SMS"

<p>Odeny, T. A., Onono, M., Owuor, K., Helova, A., Wanga, I., Bukusi, E. A., ... Abuogi, L. L. (2018). Maximizing adherence and retention for women living with HIV and their infants in Kenya (MOTIVATE! study): Study protocol for a randomized controlled trial. <i>Trials</i>, 19, 77. https://doi.org/10.1186/s13063-018-2464-3</p>	<p>Study protocol (no outcomes)</p>
<p>Peter, J. (2018). Achieving scale, sustainability and impact: A donor perspective on a mobile health messaging service and help desk (MomConnect) for South African mothers. <i>BMJ Global Health</i>, 3, e000562. https://doi.org/10.1136/bmjgh-2017-000562</p>	<p>Qualitative, informative study (no pre-post-test)</p>
<p>Pila, S., Lauricella, A. R., & Wartella, E. (2019). Using short message (SMS) and multimedia messaging (MMS) to encourage positive parent-child engagement around literacy and language development. <i>Mobile Media and Communication</i>, 7(2), 265–285. https://doi.org/10.1177/2050157918812224</p>	<p>Unrelated outcomes: parent perceptions and attitudes toward two mobile interventions</p>
<p>Price, S., Ferisin, S., Sharifi, M., Steinberg, D., Bennett, G., Wolin, K. Y., ... Taveras, E. M. (2015). Development and implementation of an interactive text messaging campaign to support behavior change in a childhood obesity randomized controlled trial. <i>Journal of Health Communication</i>, 20(7), 843–850. https://doi.org/10.1080/10810730.2015.1018582</p>	<p>6-12 year olds</p>
<p>Ruton, H., Musabyimana, A., Gaju, E., Berhe, A., Grépin, K. A., Ngenzi, J., ... Law, M. R. (2018). The impact of an mHealth monitoring system on health care utilization by mothers and children: An evaluation using routine health information in Rwanda. <i>Health Policy and Planning</i>, 33(8), 920–927. https://doi.org/10.1093/heapol/czy066</p>	<p>Community health workers receive SMSs, not the caregivers</p>
<p>Singh, J. K., Kadel, R., Acharya, D., Lombard, D., Khanal, S., & Singh, S. P. (2018). "MATRI-SUMAN" a capacity building and text messaging intervention to enhance maternal and child health service utilization among pregnant women from rural Nepal: Study protocol for a cluster randomised controlled trial. <i>BMC Health Services Research</i>, 18, 447. https://doi.org/10.1186/s12913-018-3223-6</p>	<p>Study protocol (no outcomes)</p>
<p>Su, Y., Yuan, C., Zhou, Z., Heitner, J., & Campbell, B. (2016). Impact of an SMS advice programme on maternal and newborn health in rural China: Study protocol for a quasi-randomised controlled trial. <i>BMJ Open</i>, 6, e011016. https://doi.org/10.1136/bmjopen-2015-011016</p>	<p>Study Protocol</p>

<p>Suh, H., Porter, J. R., Racadio, R., Sung, Y. C., & Kientz, J. A. (2016). Baby steps text: Feasibility study of an SMS-based tool for tracking children’s developmental progress. <i>AMIA Symposium, 2016</i>, 1997–2006.</p>	<p>SMS is used as a screening tool</p>
<p>Tang, S., Ghose, B., Hoque, M. R., Hao, G., & Yaya, S. (2019). Women using mobile phones for health communication are more likely to use prenatal and postnatal services in Bangladesh: Cross-sectional study. <i>Journal of Medical Internet Research, 21</i>(2), e10645. https://doi.org/10.2196/10645</p>	<p>Intervention not specific enough, not necessarily a text message system</p>
<p>Valizadeh, L., Alizadeh, M., Jafarabadi, M. A., Aghajari, P., & Mousarrezai, Z. (2017). The effect of SMS-based education on sleep knowledge of mothers of primary school students: A single-blind randomized controlled trial. <i>Iranian Red Crescent Medical Journal, 19</i>(3). https://doi.org/10.5812/ircmj.41293</p>	<p>Children are 7-12 years old</p>
<p>Van Velthoven, M. H., Li, Y., Wang, W., Chen, L., Du, X., Wu, Q., ... Car, J. (2015). Prevalence of mobile phones and factors influencing usage by caregivers of young children in daily life and for health care in rural China: A mixed methods study. <i>PLoS ONE, 10</i>(3), 1–24. https://doi.org/10.1371/journal.pone.0116216</p>	<p>Outcomes are unrelated to inclusion criteria</p>
<p>Victor Mwapasa; George Pro; Jobiba Chinkhumba; Mavuto Mukaka; Emily Kobayashi; Adrian Stuart; Andrews Gunda; Jessica Joseph; Nandita Sugandhi; Frank M. Chimbwandira; Michael Eliya. (2014). Mother–infant pair clinic and SMS messaging as innovative strategies for improving access to and retention in eMTCT care and option B+ in Malawi: A cluster randomized control trial (the PRIME study). <i>Journal of Acquired Immune Deficiency Syndromes, 63</i>, S120–S124. https://doi.org/10.3109/13813458509079589</p>	<p>Study protocol (no reported outcomes)</p>
<p>Wang, X., Luo, R., Liu, C., Zhang, L., Yue, A., Medina, A., & Rozelle, S. (2018). Using daily text messages to improve adherence to infant micronutrient powder (MNP) packets in rural western China: A cluster-randomized controlled trial. <i>PLoS ONE, 13</i>(1), e0191549. https://doi.org/10.1371/journal.pone.0191549</p>	<p>Text messaging is only a small element of intervention and used entirely for reminders</p>
<p>Wen, L. M., Rissel, C., Baur, L. A., Hayes, A. J., Xu, H., Whelan, A., ... Phongsavan, P. (2017). A 3-arm randomised controlled trial of Communicating Healthy beginnings Advice by Telephone (CHAT) to mothers with infants to prevent childhood obesity. <i>BMC Public Health, 17</i>(1), 1–11. https://doi.org/10.1186/s12889-016-4005-x</p>	<p>Study not yet conducted (no reported outcomes)</p>

Xiong, K., Kamunyori, J., & Sebidi, J. (2018). The MomConnect helpdesk: How an interactive mobile messaging programme is used by mothers in South Africa. <i>BMJ Global Health</i> , 3, e000578. https://doi.org/10.1136/bmjgh-2017-000578	Reported outcomes are not related to inclusion criteria (establishing what information caregivers need)
Zahid, A., & Reicks, M. (2018). A Newsletter/Text Message Intervention Promoting Beverage-Related Parenting Practices: Pilot Test Results. <i>Health Promotion Practice</i> , 1–8. https://doi.org/10.1177/1524839918779381	Children 6-12 years
Zhang Y; Chen L; van Velthoven MH; Wang W; Liu L; Du X; Wu Q; Li Y; Car J. (2013). mHealth Series: Measuring maternal newborn and child health coverage by text messaging - a county-level model for China. <i>Journal of Global Health</i> , 3(2), 020402. https://doi.org/doi: 10.7189/jogh.03.020402 .	This article outlines the considerations and challenges of using mobile phones to collect data

Summary of reasons for exclusion

REASON FOR EXCLUSION	Number of studies	Percentage (%)
No outcome/study protocol	12	18
Participants do not fall within specified age range	7	10.4
Not a text messaging system; or the use of text messages did not meet inclusion criteria (e.g. Exclusively a reminder system)	20	29.9
Study design or measured outcomes did not meet inclusion criteria (e.g. feasibility study, cross sectional study)	27	40.3
Article not available in English	1	1.5
TOTAL	67	100

Appendix C: Data extraction sheet

Article	Country	Method of messaging	Content of message (reminder, support, educational information)	Type of study	Level of evidence (Robey, 2004)	time period of intervention	Target population (age range) and no. of participants	Did text messaging have a statistically significant (P < 0.05) positive/desired effect? (yes/no)	Outcomes
Brown, B., Harris, K., Dybdal, L., Malich, J., Bodnar, B., & Hall, E. (2019). Feasibility of text messaging to promote child health in a rural community on an American Indian reservation. <i>Health Education Journal</i> , 78(5), 557–569. https://doi.org/10.1177/0017896918824624	Rural American Indian reservation (USA)	text messaging	educational information	quasi-experimental design	2	5 weeks	lower income population - Caregiver of at least one child aged 3–5 years: 17 participants	yes	weight management and sedentary lifestyle health child outcome and parent behaviour
Brown, S., Hudson, D. B., Campbell-Grossman, C., & Yates, B. C. (2014). Health promotion text blasts for minority adolescent mothers. <i>MCN The American Journal of Maternal/Child Nursing</i> , 39(6), 357–362. https://doi.org/10.1097/NMC.000000000000081	USA	text messages	information and reminders	qualitative descriptive design (case series)	4	6 months	mothers ages 17-19 during the first 6 months postpartum: 5 participants	yes	immunizations health caregiver behavior
Bushar, J. A., Kendrick, J. S., Ding, H., Black, C. L., & Greby, S. M. (2017). Text4baby influenza messaging and influenza vaccination among pregnant women. <i>American Journal of Preventive Medicine</i> , 53(6), 845–853. https://doi.org/10.1016/j.amepre.2017.06.021	USA	text messaging (mainly a reminder system)	educational information and reminders	randomized control trial	1	1 year	pregnant women or mothers with child under 1 years old: 3,321 participants	yes	vaccinations health caregiver behavior

Downing, K. L., Salmon, J., Hinkley, T., Hnatiuk, J. A., & Hesketh, K. D. (2018). Feasibility and efficacy of a parent-focused, text message-Delivered intervention to reduce sedentary behaviour in 2-to 4-year-old children (Mini movers): Pilot randomized controlled trial. <i>JMIR MHealth and UHealth</i> , 6(2), e39. https://doi.org/10.2196/mhealth.8573	Melbourne, Australia	text messaging	practical support and information	pilot randomized controlled trial	1	6 weeks	caregiver with an ambulatory child (2-4 years): 57 participants (30 intervention; 27 control)	yes	weight management and sedentary lifestyle behavior	health caregiver behaviour and child outcomes
Gallegos, D., Russell-Bennett, R., Previte, J., & Parkinson, J. (2014). Can a text message a week improve breastfeeding? <i>BMC Pregnancy and Childbirth</i> , 14, 374. https://doi.org/10.1186/s12884-014-0374-2	Australia	two-way text messaging service	information and support	non-concurrent, prospective, comparison trial	2	8 weeks	mothers over 18 years who have an infant less than three months old: 200 participants (114 intervention and 86 control)	yes	Feeding practices (breastfeeding)	health caregiver behavior
Haines, J., McDonald, J., O'Brien, A., Sherry, B., Bottino, C. J., Schmidt, M. E., & Taveras, E. M. (2013). Healthy habits, happy homes: Randomized trial to improve household routines for obesity prevention among preschool-aged children. <i>JAMA Pediatrics</i> , 167(11), 1072-1079. https://doi.org/10.1001/jamapediatrics.2013.2356	USA	(1) motivational coaching by a health educator during 4 home visits and 4 health coaching telephone calls, (2) mailed educational materials and incentives, and (3) weekly text messages on adoption	educational information and support	randomized trial	1	6 months	low income - families with children aged 2 to 5 years: 121 families	yes	weight management and sedentary lifestyle behavior	health caregiver behaviour and child health outcomes

		of household routines										
Hannan, J., Brooten, D., Page, T., Galindo, A., & Torres, M. (2016). Low-income first-time mothers: Effects of APN follow-up using mobile technology on maternal and infant outcomes. <i>Global Pediatric Health</i> , 3, 1–10. https://doi.org/10.1177/2333794x16660234	USA	2-way cell phone contact and texting	support and information	randomized clinical trial	1	6 months	low-income mothers with new-born infants (up until 6 months of age): 57 participants (30 intervention; 27 control)	yes	immunizations	antenatal care visits	health care utilization/ EDV	health outcomes maternal and infant health outcomes
Hashemian, T. S., Kritz-Silverstein, D., & Baker, R. (2014). Text2Floss: The feasibility and acceptability of a text messaging intervention to improve oral health behaviour and knowledge. <i>Journal of Public Health Dentistry</i> , 75(2015), 34–41. https://doi.org/10.1111/jphd.12068	USA	text messaging	educational information and reminders	randomized controlled trial	1	7 days	mothers of a child aged 5 years or younger: 156 participants (129 treatment and 69 control)	yes	oral health			health behavior caregiver behavior
Hurwitz, L. B., Lauricella, A. R., Hanson, A., Raden, A., & Wartella, E. (2015). Supporting Head Start parents: impact of a text message intervention on parent-child activity engagement. <i>Early Child Development and Care</i> , 185(9), 1373–1389. https://doi.org/10.1080/03004430.2014.996217	USA	text message	activity suggestion and encouragement (support)	non-randomized controlled trial	2	6 weeks	caregivers of children between the ages of 0 and 5: 253 participants (119 intervention; 134 control group)	yes	developmentally appropriate learning activities	development		caregiver behavior

Jordan, E. T., Bushar, J. A., Kendrick, J. S., Johnson, P., & Wang, J. (2015). Encouraging influenza vaccination among text4baby pregnant women and mothers. <i>American Journal of Preventive Medicine</i> , 49(4), 563–572. https://doi.org/10.1016/j.amepre.2015.04.029	USA	SMS	support and reminder	novel, randomized text-based approach	1	1 year	pregnant women and mothers of infants below 1 year: 6841 participants (3021 control and 3820 intervention)	yes	vaccinations	health caregiver behavior
Kassaye, S. G., Ong'Ech, J., Sirengo, M., Kose, J., Matu, L., McOdida, P., ... Machezano, R. (2016). Cluster-randomized controlled study of SMS text messages for prevention of mother-to-child transmission of HIV in rural Kenya. <i>AIDS Research and Treatment</i> , 2016, 1–8. https://doi.org/10.1155/2016/1289328	Kenya	SMS	reminders, education and support	cluster randomized control	1	1 year (June 2012 to June 2013)	mother infant pairs: 550 participants (280 intervention arm and 270 control arm)	no	HIV	health caregiver behavior
Ladley, A., Hieger, A. W., Arthur, J., & Broom, M. (2018). Educational text messages decreased emergency department utilization among infant caregivers: A randomized trial. <i>Academic Pediatrics</i> , 18(6), 636–641. https://doi.org/10.1016/j.acap.2018.02.003	Saint Louis (U.S. state of Missouri)	text message + Enhanced standard of care (ESoC) documents	information and support	prospective randomized experiment	1	6 months	caregivers of newborns (0–10 weeks of age) receiving: 230 participants (114 in ESoC group and 117 in ESoC + Text group)	yes	Health care utilization and emergency department visits	health caregiver behavior
Lund, S., Nielsen, B. B., Hemed, M., Boas, I. M., Said, A., Said, K., ... Rasch, V. (2014). Mobile phones improve antenatal care attendance in Zanzibar: a cluster randomized controlled trial. <i>BMC Pregnancy and Childbirth</i> , 14(29), 1–10. https://doi.org/https://doi.org/10.1186/1471-2393-14-29	Zanzibar, Tanzania	SMS	educational information and reminders	cluster randomized controlled trial	1	1 year	low-income population - pregnant women (up until 42 days postpartum): 2550 participants (1311 interventions and 1239 controls)	yes	antenatal care visits	health caregiver behavior

Militello, L., Melnyk, B. M., Hekler, E. B., Small, L., & Jacobson, D. (2016). Automated behavioral text messaging and face-to-face intervention for parents of overweight or obese preschool children: Results from a pilot study. <i>JMIR MHealth and UHealth</i> , 4(1), e21. https://doi.org/10.2196/mhealth.4398	USA	face-to-face clinic visits and ecological momentary interventions using text messaging	educational information and reminders and support	pilot study: one-group pre and post-test pre-experimental design	4	7 weeks	caregiver of preschooler aged 3 through 5 years: 15 participants	yes	weight management and sedentary lifestyle behavior health caregiver behavior
Odeny, T. A., Bukusi, E. A., Cohen, C. R., Yuhua, K., Camlin, C. S., & McClelland, R. S. (2014). Texting improves testing: A randomized trial of two-way SMS to increase postpartum prevention of mother-to-child transmission retention and infant HIV testing. <i>Aids</i> , 28(15), 2307–2312. https://doi.org/10.1097/QAD.0000000000000409	Nyanza region of Kenya	text messaging	educational information	parallel-group, un-blinded, randomized controlled trial	1	1 year 1 month	pregnant women between 28 weeks gestation and delivery: 381 participants	yes	HIV health caregiver behavior
Olson, K. B., Wilkinson, C. L., Wilkinson, M. J., Harris, J., & Whittle, A. (2016). Texts for talking: Evaluation of a mobile health program addressing speech and language delay. <i>Clinical Pediatrics</i> , 55(11), 1044–1049. https://doi.org/10.1177/0009922816664721	San Francisco, USA	text messaging	educational information	pilot intervention study (observational study)	4	3 months	parents of children aged 11 to 36 months with concerning language development: 27 participants	yes	speech and language development development caregiver behavior
Palacios, C., Campos, M., Gibby, C., Meléndez, M., Lee, J. E., & Banna, J. (2018). Effect of a multi-site trial using short message service (SMS) on infant feeding practices and weight gain in low-income minorities. <i>Journal of the American College of Nutrition</i> , 37(7), 605–613. https://doi.org/10.1080/07315724.2018.1454353	Puerto Rico and Hawaii	SMS	educational information	multi-site randomized clinical feasibility trial	1	4 months	caregivers of healthy term infants 0–2 months: 170 participants	no	feeding practices health caregiver behaviour and child outcomes
Patel, A., Kuhite, P., Puranik, A., Khan, S. S., Borkar, J., & Dhande, L. (2018). Effectiveness of weekly cell phone counselling calls and daily text messages to improve breastfeeding indicators. <i>BMC Pediatrics</i> , 18(1), 1–	Nagpur, India	weekly cell phone counselling and daily text messages	information and support	two arm, hospital-based pilot study (cluster randomized control trial)	1	August 2010 – to June 2012	women in their third trimester (32– 36 weeks) until 6 months: 1037 participants (518 control	yes	Feeding practices (breastfeeding) health caregiver behavior

12. <https://doi.org/10.1186/s12887-018-1308-3>

group and 519
intervention
group)

Sharma, R., Hebbal, M., Ankola, A. V., & Murugabupathy, V. (2011). Mobile-phone text messaging (SMS) for providing oral health education to mothers of preschool children in Belgaum city. <i>Journal of Telemedicine and Telecare</i> , 17(8), 432–436. https://doi.org/10.1258/jtt.2011.110416	Belgaum, India	text messages vs pamphlets	educational information	randomized controlled trial	1	4 weeks	preschool children and their mothers (mean age around 3 years old): 143 participants (72 pamphlets; 71 SMS)	yes	oral health	health caregiver behavior
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Appendix D: Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) checklist

PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol*

Section and topic	Item No	Checklist item	(Page No.#)
ADMINISTRATIVE INFORMATION			
Title:			
Identification	1a	Identify the report as a protocol of a systematic review	1
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	1
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number	1
Authors:			
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	1
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	10
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	1
Support:			
Sources	5a	Indicate sources of financial or other support for the review	1
Sponsor	5b	Provide name for the review funder and/or sponsor	
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	
INTRODUCTION			
Rationale	6	Describe the rationale for the review in the context of what is already known	3
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	4
METHODS			
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	4-5

Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	6
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	6 and Appendix-A
Study records:			
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	7
Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	7
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	7
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	7
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	8
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	8
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	9
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2 , Kendall's τ)	
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	10
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	10

*** It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.**

From: Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart L, PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015 Jan 2;349(jan02 1):g7647.

Appendix E: Newcastle-Ottawa Scale

Newcastle-Ottawa Scale

Wells, G., Shea, B., O'Connell, D., Peterson, J., Welch, V., Losos, M., & Tugwell, P. (2018). The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analyses.

Article	Selection			Comparability		Outcome		
	Representativeness of the exposed cohort	Selection of the non-exposed cohort	ascertainment of exposure	demonstration that outcome of interest was not present at start of study	comparability of cohorts on the basis of the design or analysis	Assessment of outcome	was follow up long enough for outcomes to occur	Adequacy of follow up of cohorts
Brown, S., Hudson, D. B., Campbell-Grossman, C., & Yates, B. C. (2014). Health promotion text blasts for minority adolescent mothers. The American Journal of Maternal/Child Nursing, 39(6), 357–362. https://doi.org/10.1097/NMC.0000000000000081	Somewhat representative of the average adolescent mothers in the community	No description of the derivation of the non-exposed cohort	Structured interview/self-report (interviews)	No	Study controls for mothers during the first 6 months postpartum	Record linkage/self-report (multiple interviews/contact sessions)	Yes (6+ weeks)	No statement
Gallegos, D., Russell-Bennett, R., Previte, J., & Parkinson, J. (2014). Can a text message a week improve breastfeeding? BMC Pregnancy and Childbirth, 14, 374. https://doi.org/10.1186/s12884-014-0374-2	Truly representative of the average breastfeeding mother in the community	Drawn from a different source	Structured interview/self-report (questionnaire)	No	Study controls for mother over 18 years old, age of infant (less than three months of age); and currently breastfeeding women; did not have a diagnosed mental illness; and used a mobile phone (of any type).	Record linkage/self-report (baseline and second questionnaire)	Yes (6+ weeks)	Small number of subjects lost to follow up unlikely to introduce

<p>Hurwitz, L. B., Lauricella, A. R., Hanson, A., Raden, A., & Wartella, E. (2015). Supporting Head Start parents: impact of a text message intervention on parent–child activity engagement. Early Child Development and Care, 185(9), 1373–1389. https://doi.org/10.1080/03004430.2014.996217</p>	<p>Truly representative of the average Caregivers of children between the ages of 0 and 5 in the community</p>	<p>Drawn from the same source</p>	<p>Structured interview/self-report (questionnaire)</p>	<p>No</p>	<p>Study controls for caregivers enrolled in Early Head Start/Head Start centers; caregivers of children between the ages of 0 and 5</p>	<p>Record linkage/self-report (pre and post questionnaire)</p>	<p>Yes (6+ weeks)</p>	<p>Small number of subjects lost to follow up unlikely to introduce bias</p>
<p>Militello, L., Melnyk, B. M., Hekler, E. B., Small, L., & Jacobson, D. (2016). Automated behavioral text messaging and face-to-face intervention for parents of overweight or obese preschool children: Results from a pilot study. JMIR MHealth and UHealth, 4(1), e21. https://doi.org/10.2196/mhealth.4398</p>	<p>Truly representative of the average caregiver of preschoolers in the community</p>	<p>No description of the derivation of the non-exposed cohort</p>	<p>Structured interview/self-report (interviews)</p>	<p>No</p>	<p>Study controls for caregivers of OW/OB preschooler aged 3 through 5 years had to (a) have a preschooler with a medical diagnosis of OW/OB, defined as a BMI percentile of 85% or above; (b) possess an active mobile phone with text-messaging capability; (c) be between the ages of 18 and 45 years; and (d) give consent for participation.</p>	<p>Record linkage/self-report (pre and post survey)</p>	<p>Yes (6+ weeks)</p>	<p>Complete follow up - all subjects accounted for</p>
<p>Olson, K. B., Wilkinson, C. L., Wilkinson, M. J., Harris, J., & Whittle, A. (2016). Texts for talking: Evaluation of a mobile health program addressing speech and language delay. Clinical Pediatrics, 55(11), 1044–1049. https://doi.org/10.1177/0009922816664721</p>	<p>Truly representative of the average Parents of children aged 11 to 36 months in the community</p>	<p>No description of the derivation of the non-exposed cohort</p>	<p>Structured interview/self-report (survey)</p>	<p>No</p>	<p>Study controls for Parents of children aged 11 to 36 months with concerning language development</p>	<p>Record linkage/self-report (pre and post survey)</p>	<p>Yes (6+ weeks)</p>	<p>Small number of subjects lost to follow up unlikely to introduce bias</p>

Appendix F: Cochrane Risk of Bias Tool

Cochrane Risk of Bias Tool

Higgins, J. P., & Green, S. (2008). *Cochrane handbook for systematic reviews of interventions*. London: The Cochrane Collaboration.

Title	Selection Bias: Random sequence generation	Selection Bias: Allocation concealment	Reporting Bias: Selective reporting	Other bias: Other sources of bias	Performance bias: Blinding (participants and personnel)	Detection Bias: Blinding (participants and personnel)	Attrition Bias: Incomplete outcome data
Brown, B., Harris, K., Dybdal, L., Malich, J., Bodnar, B., & Hall, E. (2019). Feasibility of text messaging to promote child health in a rural community on an American Indian reservation. <i>Health Education Journal</i> , 78(5), 557–569. https://doi.org/10.1177/0017896918824624	unclear risk	unclear risk	low risk	low risk	unclear risk	unclear risk	low risk
Bushar, J. A., Kendrick, J. S., Ding, H., Black, C. L., & Greby, S. M. (2017). Text4baby influenza messaging and influenza vaccination among pregnant women. <i>American Journal of Preventive Medicine</i> , 53(6), 845–853. https://doi.org/10.1016/j.amepre.2017.06.021	low risk	low risk	low risk	low risk	unclear risk	unclear risk	low risk
Downing, K. L., Salmon, J., Hinkley, T., Hnatiuk, J. A., & Hesketh, K. D. (2018). Feasibility and efficacy of a parent-focused, text message–delivered intervention to reduce sedentary behaviour in 2-to 4-year-old children (Mini movers): Pilot randomized controlled trial. <i>JMIR MHealth and UHealth</i> , 6(2), e39. https://doi.org/10.2196/mhealth.8573	low risk	low risk	low risk	low risk	unclear risk	unclear risk	low risk
Haines, J., McDonald, J., O'Brien, A., Sherry, B., Bottino, C. J., Schmidt, M. E., & Taveras, E. M. (2013). Healthy habits, happy homes: Randomized trial to improve household routines for obesity prevention among preschool-aged children. <i>JAMA Pediatrics</i> , 167(11), 1072–1079. https://doi.org/10.1001/jamapediatrics.2013.2356	low risk	low risk	low risk	low risk	unclear risk	unclear risk	low risk
Hannan, J., Brooten, D., Page, T., Galindo, A., & Torres, M. (2016). Low-income first-time mothers: Effects of APN follow-up using mobile technology on maternal and infant outcomes. <i>Global Pediatric Health</i> , 3, 1–10. https://doi.org/10.1177/2333794x16660234	low risk	low risk	low risk	low risk	unclear risk	unclear risk	low risk
Hashemian, T. S., Kritz-Silverstein, D., & Baker, R. (2014). Text2Floss: The feasibility and acceptability of a text messaging intervention to improve oral health behaviour and knowledge. <i>Journal of Public Health Dentistry</i> , 75(2015), 34–41. https://doi.org/10.1111/jphd.12068	low risk	low risk	low risk	low risk	high risk	high risk	low risk
Jordan, E. T., Bushar, J. A., Kendrick, J. S., Johnson, P., & Wang, J. (2015). Encouraging influenza vaccination among text4baby pregnant	low risk	low risk	low risk	low risk	unclear risk	unclear risk	low risk

women and mothers. <i>American Journal of Preventive Medicine</i> , 49(4), 563–572. https://doi.org/10.1016/j.amepre.2015.04.029								
Kassaye, S. G., Ong'Ech, J., Sirengo, M., Kose, J., Matu, L., McOdida, P., ... Machekano, R. (2016). Cluster-randomized controlled study of SMS text messages for prevention of mother-to-child transmission of HIV in rural Kenya. <i>AIDS Research and Treatment</i> , 2016, 1–8. https://doi.org/10.1155/2016/1289328	low risk	low risk	low risk	low risk	unclear risk	unclear risk	low risk	
Ladley, A., Hieger, A. W., Arthur, J., & Broom, M. (2018). Educational text messages decreased emergency department utilization among infant caregivers: A randomized trial. <i>Academic Pediatrics</i> , 18(6), 636–641. https://doi.org/10.1016/j.acap.2018.02.003	low risk	low risk	low risk	low risk	low risk	low risk	low risk	low risk
Lund, S., Nielsen, B. B., Hemed, M., Boas, I. M., Said, A., Said, K., ... Rasch, V. (2014). Mobile phones improve antenatal care attendance in Zanzibar: a cluster randomized controlled trial. <i>BMC Pregnancy and Childbirth</i> , 14(29), 1–10. https://doi.org/https://doi.org/10.1186/1471-2393-14-29	low risk	low risk	low risk	low risk	high risk	High risk	low risk	
Odeny, T. A., Bukusi, E. A., Cohen, C. R., Yuhas, K., Camlin, C. S., & McClelland, R. S. (2014). Texting improves testing: A randomized trial of two-way SMS to increase postpartum prevention of mother-to-child transmission retention and infant HIV testing. <i>Aids</i> , 28(15), 2307–2312. https://doi.org/10.1097/QAD.0000000000000409	low risk	low risk	low risk	low risk	high risk	high risk	low risk	
Palacios, C., Campos, M., Gibby, C., Meléndez, M., Lee, J. E., & Banna, J. (2018). Effect of a multi-site trial using short message service (SMS) on infant feeding practices and weight gain in low-income minorities. <i>Journal of the American College of Nutrition</i> , 37(7), 605–613. https://doi.org/10.1080/07315724.2018.1454353	low risk	low risk	low risk	low risk	unclear risk	unclear risk	low risk	
Patel, A., Kuhite, P., Puranik, A., Khan, S. S., Borkar, J., & Dhande, L. (2018). Effectiveness of weekly cell phone counselling calls and daily text messages to improve breastfeeding indicators. <i>BMC Pediatrics</i> , 18(1), 1–12. https://doi.org/10.1186/s12887-018-1308-3	low risk	low risk	low risk	low risk	high risk	low risk	low risk	
Sharma, R., Hebbal, M., Ankola, A. V., & Murugabupathy, V. (2011). Mobile-phone text messaging (SMS) for providing oral health education to mothers of preschool children in Belgaum city. <i>Journal of Telemedicine and Telecare</i> , 17(8), 432–436. https://doi.org/10.1258/jtt.2011.110416	low risk	low risk	low risk	low risk	unclear risk	low risk	low risk	

Appendix G: Plagiarism report



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Abstract

Access to appropriate information can result in improved health and development outcomes for children. Providing information about health and developmental care via mobile devices (mHealth) can serve not only as curative healthcare but also as preventative health care in developing countries. Through mHealth programs, messages are sent by SMS or voice recorded messages. By reviewing the current state of evidence, the study aims to investigate if text messaging about health and development in young children has an effect on caregiver behaviour. This systematic review was conducted according to the PRISMA-P statement guidelines. Four databases were used to conduct this study and the search was not limited to a specific time period. Key words were used in various combinations within the different databases. Thematic analysis was used to organize and synthesize the information extracted from the selected studies. The review included 19 studies. Study designs included RCTs (n=6, 31.6%), observational studies (n=3, 15.8%), and non-randomized control trials (n=3, 15.8%). Message content included educational information regarding health and development (39.47%), reminders (26.84%) and caregiver support (22.69%). Current evidence summarized from this review supports text messaging as an effective tool to change caregiver behaviour and child outcomes across a range of health and ECD related topics as the findings suggest increased caregiver control with basic infant health and development decisions, which may be attributable to information received via text message from health care professionals. Development has more limited quality and quality of evidence and requires more studies. More research is also required in LMICs.

Key terms

health; development; caregiver; young children; text messaging; mHealth; prevention; support; educator; systematic review

Page 1

dissertation 1

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Appendix H: Proof of article submission



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